MANUAL TRAINING

FOR

SECONDARY SCHOOLS IN INDIA

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Teachers' Training Class at the Higher Grade Training College, Allahabad.

PREFACE

AS a result of the Conference held at Naini Tal in 1907 for the improvement of Secondary Education, a class for training teachers in Educational Woodwork was started at the Higher Grade Training College, Allahabad.

A course suitable to Indian conditions was worked out, and, after standing the test of two years' experience, was prescribed by the Education Department of the United Provinces for Classes VII and VIII of Anglo-Vernacular Schools, and, with some additions, by the School-Leaving Certificate Board for their certificate. This course in its final form is set out in detail in this book. It consists of a series of exercises, designed to introduce the pupil to tool manipulations in order of difficulty. These exercises, however, are not the only ones which can serve this purpose. On the contrary, they are only suggestive. The teacher should endeavour to stimulate the inventive powers of pupils by encouraging them to design for themselves models which can be executed by the prescribed tool operations.

The aim of the course is an educational one,—to give dexterity to the hand and accuracy to the eye, to develop self-reliance, to cultivate habits of neatness and exactness, and to train to patience and perseverance. It does not aim at making boys mechanics; it will nevertheless, by developing a taste and cultivating a respect for manual work, predispose towards industrial life boys who would otherwise swell the ranks of candidates for clerical posts.

The author is indebted to Mohammad Nasir Husain Khan, his assistant, who executed the drawings, and gave many valuable practical suggestions. He has to express his obligations also for general suggestions obtained from the writings of those teachers who have led the way in the development of Manual Instruction in England.

In the Appendix particulars are given regarding the building, furnishing, and equipping of a Manual Training Workshop.

A. H. M.

DRAWING

LESSON 1.[*]

Materials and Instruments for Drawing.

The following materials and instruments are necessary:—Pencil, Paper, Rubber, Ruler, Dividers, Set-squares, Drawing-board, Drawing-pins, T-square.

Pencil.—The best kind of pencil to use is a fairly hard one (F. or H. B.). Neatness and accuracy depend on having well-sharpened pencils. *You should have two pencils*, one sharpened to a fine point, as in Fig. 1(*a*), and the other to a flat "chisel point," as in Fig. 1(*b*); the former is used for marking points and the latter for drawing lines.

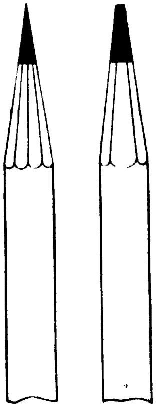
(*a*) (*b*)

Fig. 1

Paper.—This should be of good quality, with a smooth surface which will not peel off easily under the action of the rubber. A convenient size is 15″ × 12″.

Rubber.—This should be free from grit, and not so soft as to wear away easily. When used it should be rubbed in one direction only; if you rub it backwards and forwards you are apt to dirty and tear the paper.

Ruler.—Any good ruler will do, but it will be an advantage to have one showing centimetres as well as inches, and having the inches divided into tenths, twelfths, and sixteenths. Fig 2 shows portions (the front and back views of such a ruler.

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[*] NOTE. For convenience the book is divided into "lessons," but these may occupy the class for several lesson periods.

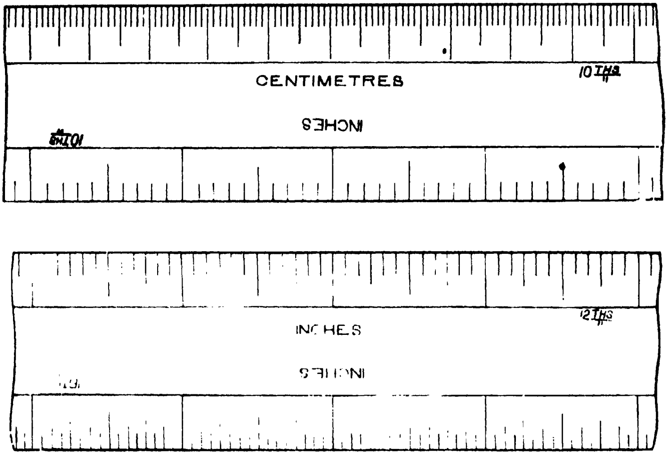


Fig. 2.

A precaution to remember in using a ruler is that when a mark or measurement is being made at a particular point of the ruler, the eye should be placed vertically over the point.

Dividers.—This instrument (Fig. 3) consists of two sharp pointed legs hinged together. It is useful for marking on a drawing a measurement of a given length. The measurement is taken by opening out the legs so that the points are the required distance apart. Sometimes this distance is taken from a drawing and sometimes from the ruler.

Fig. 3.

Set-Squares.—These are shown in Fig. 4. They are used for drawing perpendicular lines, parallel lines, and lines at angles of 30°, 45°, and 60°.

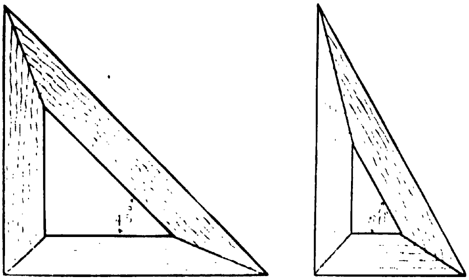


Fig. 4.

Drawing-board.—A convenient size of board is 20 inches long and 16 inches wide. It should be well constructed, so that it will not warp in the hot weather. The paper is attached to the Drawing-board by four *drawing-pins*, as shown in Fig. 5.

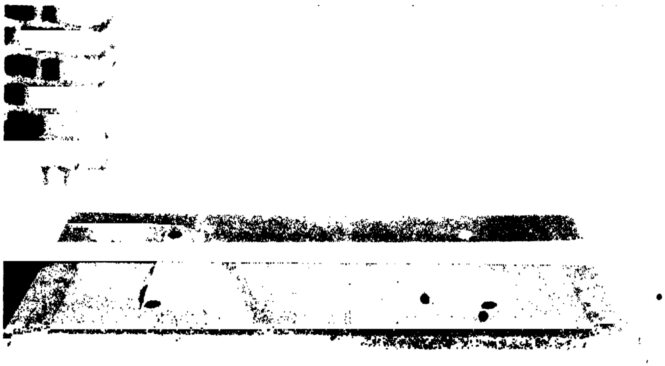


Fig. 5.

T-square.--This is used with the Drawing-board, as shown in Fig. 5. The T-square is moved up and down the Drawing-board by sliding the cross piece (called the *Stock*) against the left-hand edge of the Drawing-board. There must be complete contact between the stock and the edge of the board. The best way to keep the T-square in position when a line is being drawn is shown in Fig. 6.

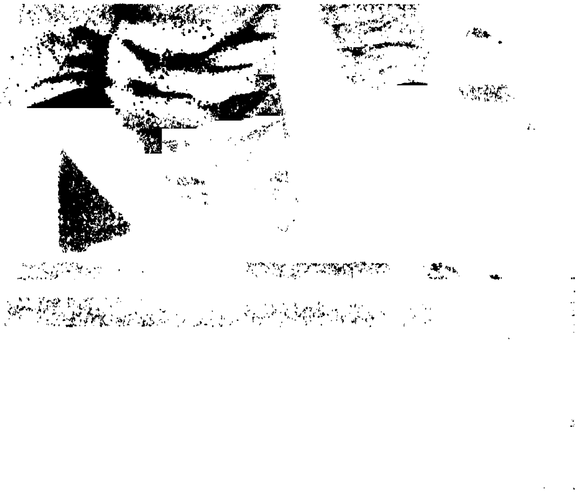


Fig. 6.

LESSON 2.

Drawing of Lines.

Exercise 1.—*To draw straight lines of given length.*

Proceed as follows:—Lay the ruler flat on the paper, and, holding it firmly by the four fingers of the left hand, in the manner shown in Fig. 7. make two dots at the required distance apart. The first dot should not be made at the 0 mark, as the ruler is generally worn at the end, but at the 1″ or 2″ mark. The pencil should be held nearly vertical, as shown in the figure. In drawing the line the pencil should be pressed against the ruler only sufficiently hard to keep the point always at the same distance from the edge of the ruler.

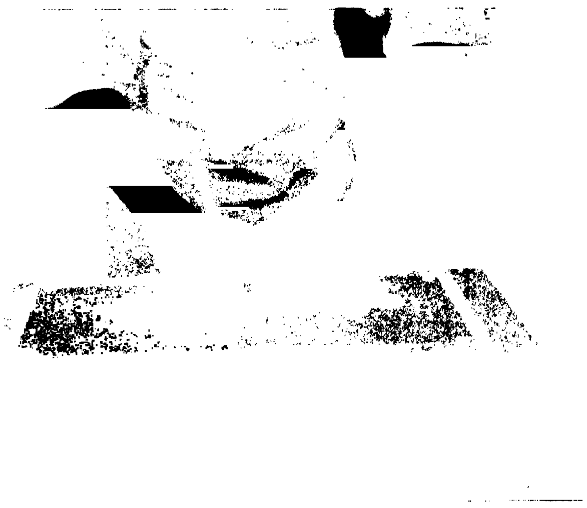


Fig. 7.

Draw straight lines of the following lengths:—

$6\frac{1}{4}$ inches; $2\frac{1}{2}$ inches; $4\frac{1}{10}$ inches ... All in the direction of the long side of the paper.

$3\frac{7}{12}$ „ ; $2\frac{7}{8}$ „ ; $4\frac{1}{8}$ „ ... All in the direction of the short side of the paper

$3\frac{2}{3}$ „ ; $3\frac{1}{6}$ „ ; $5\frac{1}{3}$ „ ... All obliquely across the paper.

Exercise 2.—*To draw a number of lines perpendicular to a given line.* Draw a line AB 5″ long (Fig. 8). Mark on it four points D_1, D_2, D_3, D_4, 1″ apart. Place the ruler along AB and slightly below it. Place the set-square against the ruler so that one of the edges forming the right angle almost passes through the point D_1. The ruler and set-square should be held as shown in Fig. 9 by placing the first and fourth fingers of the left hand on the ruler, and the second and third fingers on the set-square.

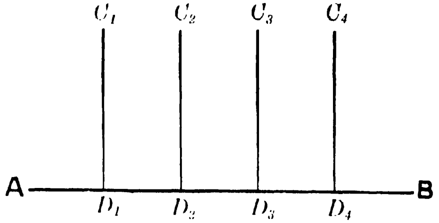


Fig. 8.

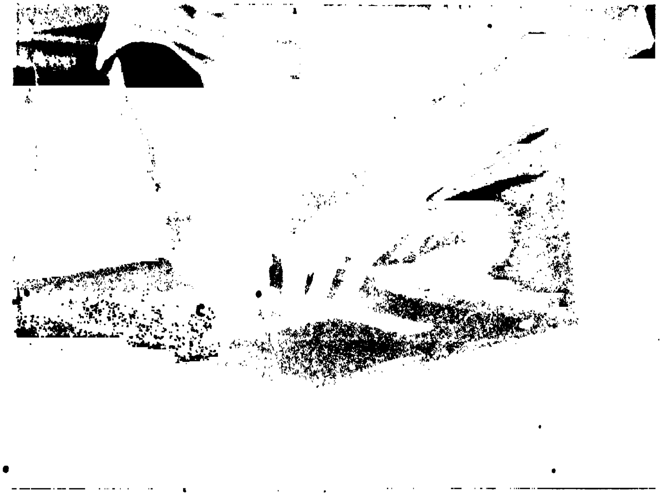


Fig. 9.

The first and fourth fingers will hold the *ruler* in position, and the second and third fingers, which should be pressed downwards, will exert a slight pull towards the ruler and so hold the *set-square* in position. The perpendicular line C_1 D_1 should then be drawn through the point D_1, as shown in Fig. 9, the pencil being held in the right hand nearly vertically. To draw the line C_2 D_2 raise the two fingers of the left hand from the set-square, and move the set-square by the second finger of the right hand (Fig. 10) until the edge passes through the point D_2. The figure shows how the pencil may be held when this is being done. When the set-square is being moved the finger which moves it should also keep it pressed slightly against the ruler.

Fig 10.

Exercise 3.—*To draw parallel lines at angles of 30°, 45°, and 60° to a given line.*

Proceed as in the last exercise using the other edges of the set-squares as shown in Fig. 11.

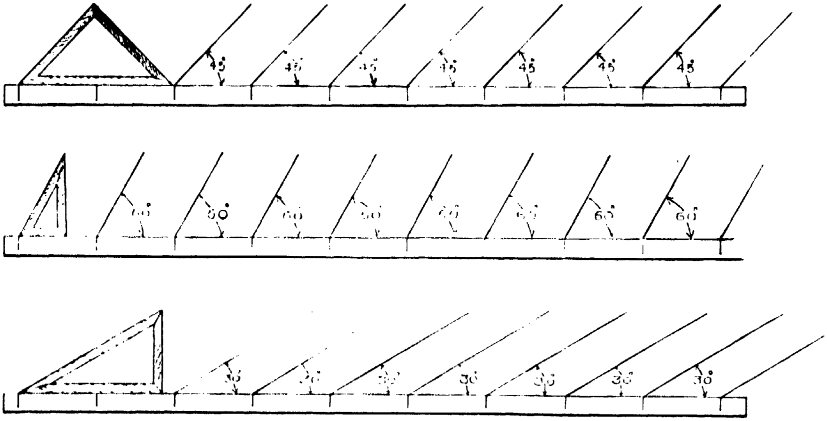


Fig. 11.

Exercise 4.—*To draw a number of lines parallel to a given line.*

Draw a line AB (Fig. 12). Place one edge of the set-square through the line, as shown in Fig. 12. Place the ruler so that another edge of the set-square lies along it and then move the set-square along the ruler, as in the previous exercise. If the set-square be moved in the direction of the arrow (Fig. 12) the parallel lines $A_1 B_1$, $A_2 B_2$, etc., may be drawn.

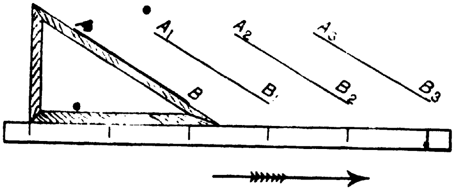


Fig. 12.

Exercise 5.—*To make a figure formed of parallel and perpendicular lines.*

Draw the given figures (Fig. 13 and Fig. 14).

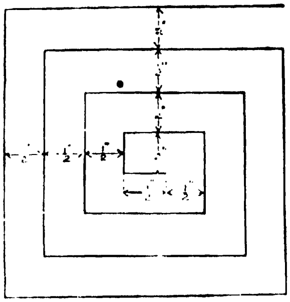


Fig. 13.

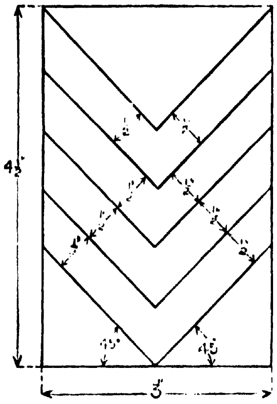


Fig. 14.

Note that the *dimensions* of figures are given in the centre of a broken line which ends in short arrows; the dimension is the distance between the points of the arrows.

LESSON 3.

Drawing of Solids.

You are given a solid (4″ × 3″ × 2″), (Fig. 15). Place it on the table and look at it horizontally in the direction of the arrow R, so that only

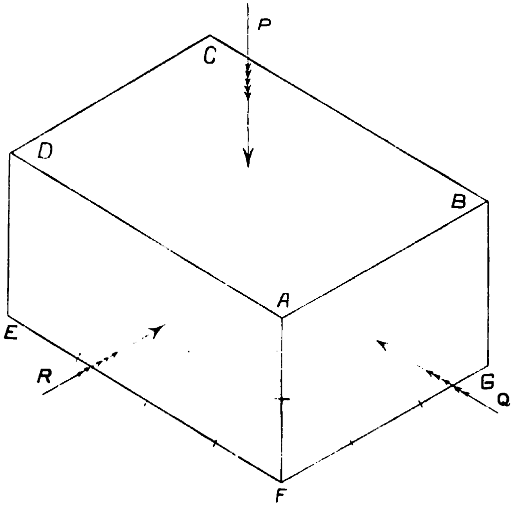


Fig. 15.

the rectangle AFED can be seen, and draw this rectangle. This is called the **Elevation** of the solid (Fig. 16). Now look vertically down on the solid in the direction of the arrow P, so that nothing but the top side can be seen. Draw the rectangle ABCD which you see. This is called the **Plan** of the solid (Fig. 16). Finally look at the solid, again horizontally but in the direction of the arrow Q, so that only the rectangle ABGF can be seen. Draw this rectangle. This is called the **Side View** of the solid (Fig. 16.)

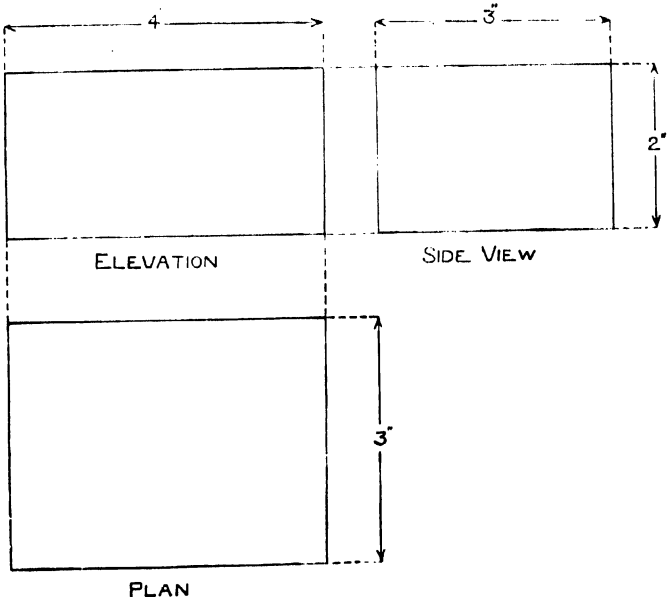


Fig. 16.

We may express this in another way. Your teacher will show you three black-boards hinged together at right angles (Fig. 17).

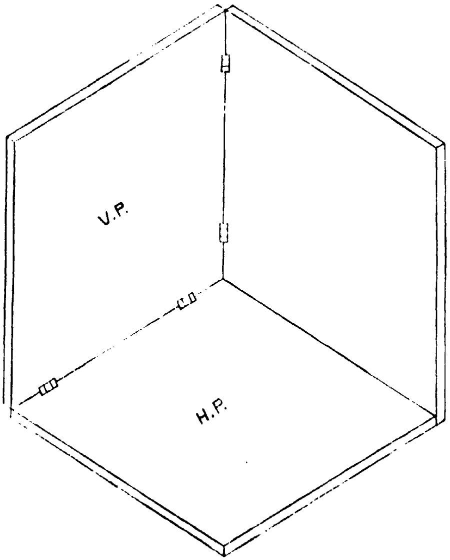


Fig. 17.

[°] The front vertical board VP is called the *Vertical Plane* and the horizontal board HP is called the *Horizontal Plane*. The teacher will place the solid between the planes as shown in Fig. 18.

Imagine the four horizontal edges of the solid which are perpendicular to the vertical plane, to be produced to meet it; we get the *elevation*. Imagine the four vertical edges produced to meet the horizontal plane; we get the *plan*. Similarly, if we produce the other horizontal edges to meet the third black-board we get the *side view*.

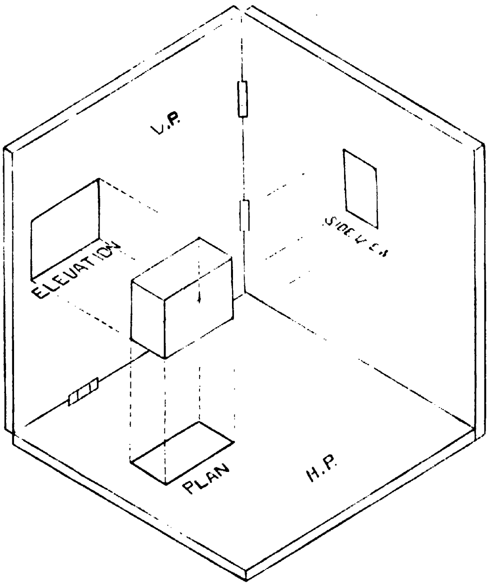


Fig. 18.

All these drawings show only two dimensions of the solid; the *elevation* shows the length and height, the *plan* shows the length and breadth, and the *side view* shows the height and breadth. It is convenient to show in one drawing *all* the dimensions of the block. Such a drawing which will show all three dimensions, gives a clear idea of the appearance of the object as a whole. It is called **a Conventional Isometric Projection.**

To draw a conventional isometric projection of the block proceed as follows:—

Draw a horizontal line AB (Fig. 19).

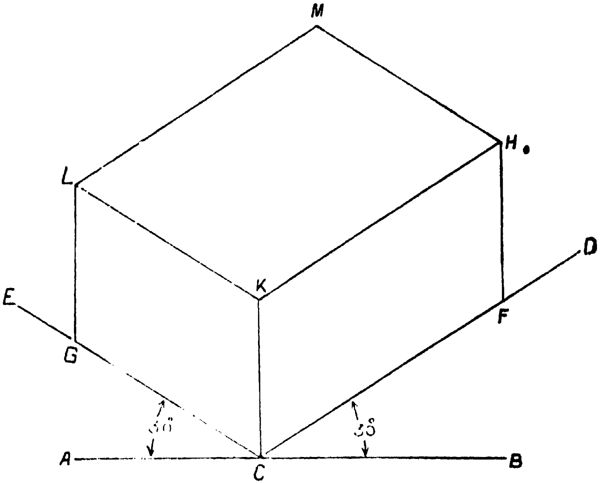


Fig. 19.

At any point C draw lines CD CE each making an angle of 30° with the line AB. Mark off a distance CF on CD of length 4″ (the length of the block) and on CE mark off CG of length 3″ (the width of the block). At F, C, G, draw FH, CK, GL, each of length 2″ (the height of the block) and all perpendicular to AB. Join HK, and KL, and draw HM parallel to KL and LM parallel to KH. The figure you have now drawn is the *conventional isometric projection* of the solid.

Exercise 6.—*Make a drawing in conventional isometric projection of the same block standing on its end.*

WOOD-WORK

LESSON 4.

Tools used.—*Jack Plane, Try Square.*

Tool Manipulations.—*Face Planing, Edge Planing.*

Jack Plane.—This is a tool for making a rough surface of wood even. Fig. 20 shows the general appearance of the Jack Plane. It is about 16″ long, 2½″ wide, and 3″ deep.

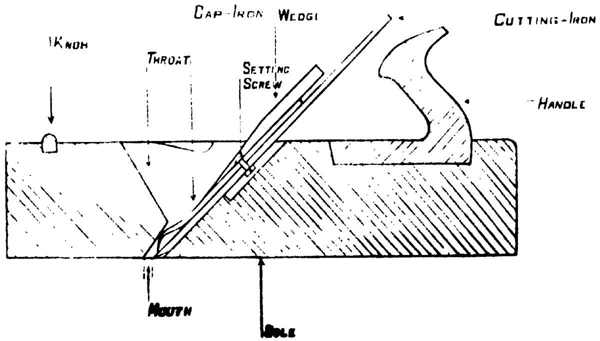


Fig. 20.

Examine your plane. Notice especially the knob, throat, irons, wedge, and handle. Turn the plane over and notice the flat sole, and the cutting iron projecting slightly from the mouth. Now you will take your plane to pieces. Hold it as shown in Fig. 21. (Notice that the plane is held by the fingers of the left hand.) Hold the hammer in the

Fig. 21.

right hand and give a few sharp taps on the knob of the plane; thus the wedge is loosened. Put the hammer down and take out the wedge and irons. Examine the irons. They consist of a cutting-iron and a cap-iron (Fig. 22.)

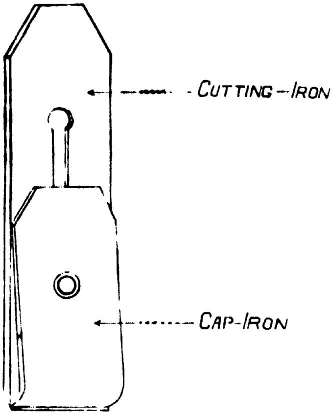


Fig 22.

The chief use of the cap-iron is to prevent the wood from splitting by turning the shaving aside and breaking it as soon as it is cut from the wood. Fig. 23 shows how a shaving is turned aside by the cap-iron; as the lower opening of the throat of the plane is narrow, the shaving is broken as the plane moves forward and the broken shaving passes out through the throat. Notice that the edge of the cutting-iron is about $\frac{1}{16}$" below the edge of the cap-iron. Sometimes it will be necessary for you

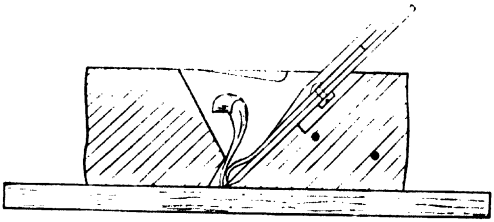


Fig. 23.

to unscrew the cap-iron from the cutting-iron in order to sharpen the latter; you will then proceed according to the directions given in the Appendix.

To replace the irons, hold the plane with the left hand, as shown in Fig. 24. The irons are inserted in the throat until the cutting edge projects from the sole a distance equal to the thickness of the shaving required. (You will find it easier to begin by taking off very thin shavings). If when you are inserting the irons you place the first two fingers of the left hand at the mouth of the plane, you will be able to

Fig. 24.

judge by feeling the cutting edge, whether it is straight and projecting to the right extent. The thumb of the left hand should be pressed on the irons to keep them in position while the wedge is inserted with the right hand and driven in with the hammer. If, after the wedge has been driven in, too much of the cutting edge appears below the sole, a tap with the hammer on the knob will cause it to go back. If, on the other hand, too little of the edge shows below, tap the top of the iron with the hammer. A tap with the hammer on an edge of the iron will set it right if one corner of the cutting edge is lower than the other. After any of these adjustments, the wedge should be tightened.

Try Square.—This consists of a rectangular steel blade firmly fixed *at right angles* into a hard piece of wood (called the *stock*) (Fig. 25.)

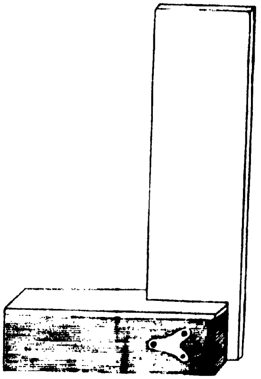


Fig. 25.

It is used for drawing lines at right angles to an edge of a block of wood or in testing whether two edges are at right angles.

Exercise 1.—*To plane a side and the edges of a block of wood.*

You are given a block of wood (about $12'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$) and are required to plane one side and two edges, so that the edges will be at right angles to the side. (Of the six surfaces of a block, there are two at the ends and four others. Of these four, we call the broad ones *sides*, and the narrow ones *edges*).

(*a*) *To plane a side.*—Place the wood on the bench against the stop and hold the plane as shown in Fig. 26. Notice that you must stand

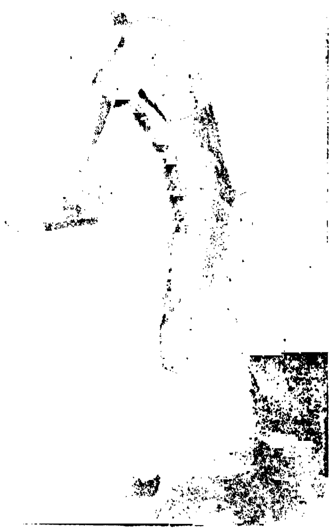


Fig. 26.

behind the plane with the feet apart, and that the handle is grasped firmly with the right hand, while the left hand presses over the knob of the plane. Push the plane forward, using the arms only (not the trunk of the body). At the beginning of the stroke press the front of the plane firmly down with the left hand, but, as the plane moves over the wood, release this pressure, and *gradually increase the pressure on the other end* of the plane, by the right hand. The plane should be moved in the direction in which the fibres of the wood run, called the ***grain***, and on the return stroke should be lifted off the wood. The planing should be continued until the surface is level. The surface is tested first by the eye and then by placing the *steel rule*[*] across the wood in different directions, and holding the wood and rule up to the light, as shown in Fig. 27.

Fig. 27.

When the surface is true it should be marked (See Fig. 28) to distinguish it. The planed face is called the *face side*. It is useful also to mark with an arrow on one face of the wood the direction of the grain.

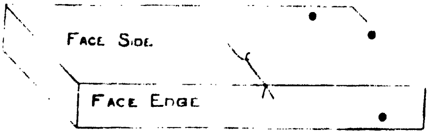


Fig. 28.

[*] **Note.—The steel rule is divided into tenths of an inch on one edge, and into sixteenths on the other. As it is made of steel it does not wear away easily or lose its shape; on this account it may be used as a "straight edge."**

(b) To plane an edge.—Place the wood in the vice, as shown in Fig. 29. The plane is used as before, but the pressure on the front is applied only by the thumb of the left hand. The fingers are allowed to move along the face side in order to steady the plane. In order to

Fig. 29.

test whether the edge is plane and at right angles to the face side, use the try square, as shown in Fig. 30.

Fig. 30.

When the edge has been planed it is called the *face edge* and is marked by continuing the mark on the face side (See Fig. 28). The direction in which the grain runs also should be marked by an arrow head.

For further practice in planing, plane the other edge of the wood so that it will be at right angles to the face side.

LESSON 5.

Tools used.—*Marking Gauge.*

New Tool Manipulation:—*Gauging.*

Marking Gauge.—This is used for making lines on wood parallel to one edge. It consists of four parts: A, the stem, (Fig. 31) which passes through the stock, B, to which it may be firmly fixed in any position by the thumb screw C; near the end of the stem is the spur D, which is a short piece of steel, sharpened to rule lines on wood.

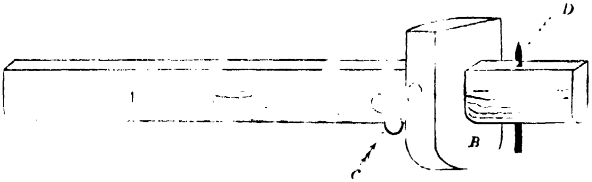


Fig. 31.

Exercise 2.—*To mark lines on a block of wood by means of the marking gauge.*

On the piece of wood, of which in Lesson 4 you planed a side and edges, you are required to draw lines on the side and on an edge.

(*a*) *To draw lines on the side.*—Hold the marking gauge in the left hand by the stock with the stem passing between the first and second fingers, and, having loosened the screw, adjust the spur to a distance of

3½" from the stock by tapping one end of the stem on the bench. Fig. 32 shows how the adjustment is finally made. Tighten the screw.

Fig. 32.

Set the end of the wood against the bench stop, so that the grain of the wood is running towards the stop. Place the face of the stock against the edge of the wood and then press the pin slightly into the wood. The line is marked by pushing the gauge steadily along the wood, with the pin at a slight inclination towards the direction in which it is moving.

Notice how the wood and gauge are held (Fig. 33). When the line is being drawn the stock should be *in complete contact* with the edge of the wood

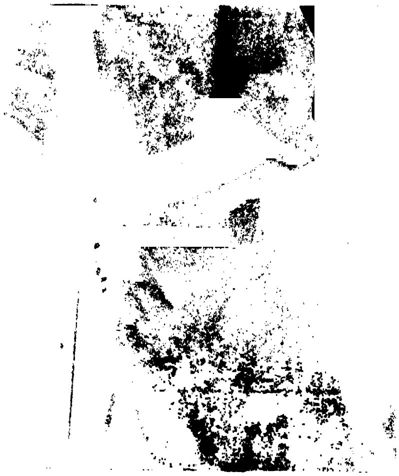


Fig. 33.

‘Draw other lines adjusting the gauge to the following distances: 3", 2¾", 2⅛", 2¼", 1⅞", 1⅝", 1", ⅛".

(*b*) *To draw lines on an edge.*—Place the wood in the vice, (Fig. 34). Draw 4 lines on the edge $\frac{1}{8}''$ apart. The figure shows how the hands are placed, so that a line may be steadily drawn.

Fig. 34.

LESSON 6.

Tools used.—*Marking Knife, Smoothing Plane, Tenon Saw,* Jack Plane, Try Square, Marking Gauge.

New Tool Manipulations.—*Marking with knife, sawing with tenon saw at right angles to the grain, end planing.*

Marking Knife.—You will use this knife to mark lines on wood. It consists of a blade of steel fitted into a handle. The blade is oblique, (Fig. 35).

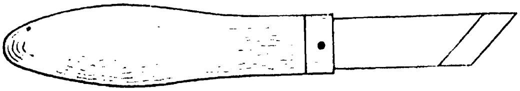


Fig. 35.

Smoothing Plane.—The general shape of this plane is shown in Fig. 36. Being only about 8″ long it is useful for planing short surfaces, such as the ends of a prism. The irons, wedge, and the throat, etc., are the same in principle as in the Jack Plane, but the Smoothing Plane, being small, can be pressed down more firmly than the Jack Plane against the surface of the wood. Also the edge of the cutting iron of the Smoothing Plane, unlike that of the Jack Plane, is straight, and so does not make slight grooves in the surface of the wood. It is therefore used for making

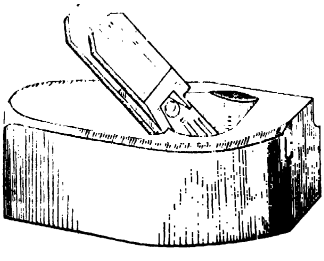


Fig. 36.

a smooth surface. For sharpening the cutting iron of the Smoothing Plane, see the Appendix.

Tenon Saw.—This saw is shown in Fig. 37. Notice that the teeth of the saw are not in the same line. They are bent alternately in opposite directions. This is called the "set" of the saw. The object of the set is to enable the teeth to clear a space, called the *clearance*, for the blade of the saw (Fig. 38). Pupils should not try to sharpen their own saws; the operation is a difficult one and, should pupils attempt it, they will probably only make their saws more blunt and perhaps permanently injure them. The teacher should take some lessons from an experienced mechanic on saw sharpening, and, after he has practised with an old one and acquired skill, he will be able to keep the saws of the pupils in good working condition. Until the teacher acquires this skill the saws should be sharpened by a mechanic. They should not require sharpening more than once a year.

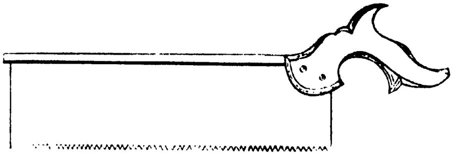


Fig. 37.

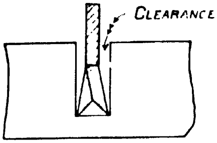


Fig. 38.

Exercise 3.—*To make a rectangular prism and to cut from it a number of blocks of equal dimensions.*

The piece of wood given to you to work from is about 12″ × 2¼″ × 1″. You are required first to make a rectangular prism 9″ × 2″ × ¾″.

Plane a side and an edge at right angles to each other, as in Exercise 1, and mark these.

To make the wood the required thickness.—Set the marking gauge to ¾", and mark a line on the face edge at this distance from the face side. Turn the other edge uppermost and mark it in the same way. Now plane the bottom side of the wood to the depth of the gauged lines, and test it by the steel rule and try-square to see that it is a plane surface and at right angles to the face edge.

To make the wood the required width.—Set the marking gauge to 2" and mark a line on the face side, at this distance from the face edge. Turn the wood over and mark a line in the same way, on the opposite side. Plane the second long edge of the wood to the depth of these gauged lines, and test by the try-square to see that it is a plane surface and at right angles to the face side.

To make the wood the required length.—Using the try-square and marking knife draw a continuous line at right angles to the edges, about ⅛" from one end. Fig. 39 shows how this is done. The try-square is

Fig 39.

held firmly against the wood and the line is drawn by holding the knife like a pen and making the cut with the point of the knife. Now place the wood in the vice and plane it down to the line by using the smoothing plane. Fig. 40 shows how the smoothing plane is used. In order to prevent the plane breaking the edge of the wood when leaving it, a good plan is to place another piece of wood (the piece used in Exercises 1 and 2 would be suitable) close up against the piece being planed. The other piece of wood should be of width not less than that of the piece being planed.

Fig. 40.

By means of the ruler, try-square, and marking knife draw another continuous line round the wood, at right angles to the edges, at a distance of 9″ from the planed end. Fig. 41 shows how this measurement should be made.

Fig. 41.

Saw off the portion of wood projecting beyond the line drawn, making the saw-cut about ⅛" from the right side of this line. The extra ⅛"

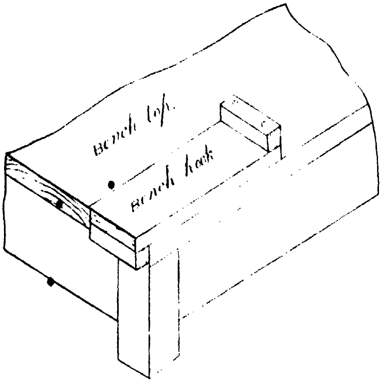


Fig. 42.

of wood is left to be planed off with the smoothing plane (see below). In order to saw off the projecting portion you use the *bench hook.*

The bench hook consists of a slab of wood (about 9″ × 6″ × 1″) with two pieces (about 6″ × 1½″ × 1″) screwed on opposite ends (Fig. 42). The object of the bench hook is to enable one to hold a piece of wood in position while sawing it. It also prevents the saw from injuring the bench. The drawing shows how the bench hook is placed on the bench. The bench hook may also be fastened in the vice as shown in Fig. 43. The forefinger of the right hand is extended and pressed against the side

Fig. 43.

of the saw, which is held upright. The wood is held by the left hand, whose forefinger guides the saw when commencing to cut.

Begin by making a light pulling stroke on the end of the wood furthest from you, and follow this by a light pushing stroke. The first cut should be made with the further end of the saw held in position (1) Fig. 44.

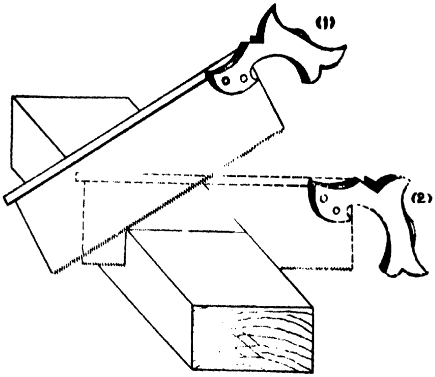


Fig. 44.

Gradually lower the saw until position 2 is reached. Do not press on the saw, but use a light stroke; the saw will then make its own way through the wood. Now, using the smoothing plane, plane the second end down to the marked line, as in the case of the first end (Fig. 40). *The teacher will now examine the prism which you have made.*

For further practice in sawing, draw 6 continuous lines round the wood at distance of 1″ apart, and saw off from the wood 6 small prisms, 1″ × $\frac{3}{4}$″ × 2″. After cutting each piece, test with the try-square to see whether or not you have made a cut at right angles to the edges.

LESSON 7.

Tools used.—Jack Plane, Try-square, Marking Gauge, Marking Knife, Smoothing Plane, Tenon Saw.

Excercise 4.—*Square Prism.*

The teacher has a few completed models* of what you are to make.

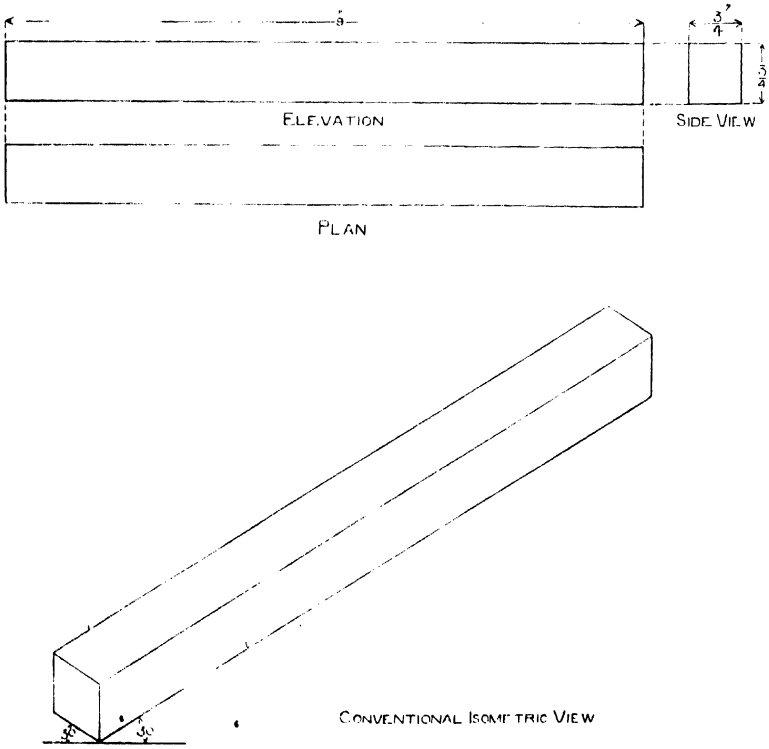


Fig. 45.

*** The teacher will have no difficulty in providing *class models* after the course has been going on for a year, as he may keep for this purpose the best models made by his first year's class.**

We shall call these *class models.* First take measurements from one of these models and make a rough dimensioned sketch of it. Now you will work entirely from your own drawings, except when you are in a difficulty, when you may refer to the completed model again.

From your rough sketch make careful full-size drawings (elevation, plan, side view, and conventional isometric sketch) of the model (Fig. 45). The drawing is said to be *full-size* when its dimensions are the actual dimensions of the model. (Do not take any measurements from the drawings in the book as these are not full-size.)

These are your *working drawings.* Using these as a guide, you are required to make from the piece of wood supplied to you a prism of the dimensions given in your drawing.

The model is made in the same way as the prism of Exercise 3, but when finished will be in section (*i.e.*, when cut across perpendicular to its length at any point) a perfect square.

NOTE. - You will keep this and all future models which you make. When you have completed a model put a label on it and write on the label - (1) your name; (2) the time taken (in hours) in making the model. The teacher will initial the label, if he thinks that the work is satisfactory. If the work is not satisfactory you must repeat the exercise.

LESSON 8.

Tools used.—Jack Plane, Try-square, Marking Gauge, Marking Knife, Tenon Saw, Smoothing Plane.

New Tool Manipulation.—*Sawing with tenon saw with the grain.*

Exercise 5.—*Rectangular Prism with longitudinal and transverse saw cuts.*

You are given a piece of wood about 12″ × 2¼″ × 1″ and are required to make from it a model similar to that of the class model, which is a rectangular prism with saw cuts to given depths; some of the saw cuts are parallel to the length of the wood (longitudinal) and others are made across the wood (transverse). Make sketches of one of the class models. Then make careful full-size working drawings (Fig. 46).

Make a rectangular prism of the dimensions given in your drawing.

Mark with pencil, using the try-square, transverse lines all round the prism at a distance of 1½″ from each end; these are guide lines showing to what depth the longitudinal cuts have to be made. With the gauge, mark lines on each side of the prism at a distance of 1¼″ from the face edge. Go over these lines with pencil, using the ruler to guide the pencil. These are guide lines showing to what depth the transverse cuts have to be made. Mark out the longitudinal lines with the gauge at the distance apart shown in Fig. 46, but, in order that they may be easily seen, go over them afterwards with the pencil, using the try-square to guide the pencil. Mark out the transverse lines at the distance apart shown in Fig. 46, using the try-square and marking knife. Go over them with the pencil. All lines should be continued round the edges and marked on both sides of the prism. Place the wood in the vice and saw along the marked lines to the depth of the guide lines.

Finally, smooth down the rough edges of the cuts by using the smoothing plane.

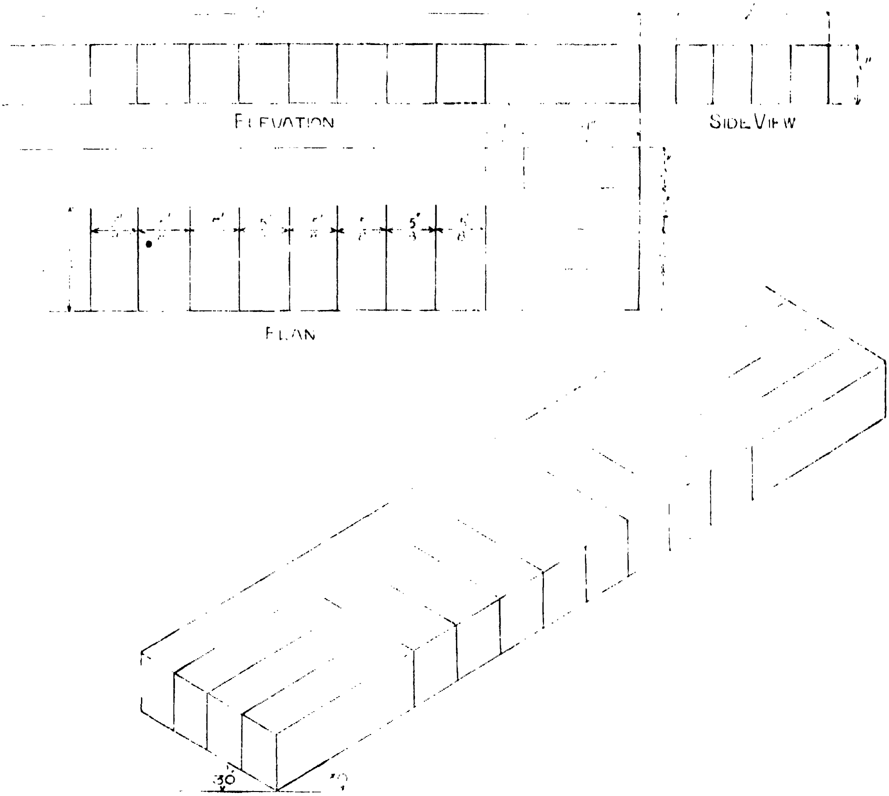


Fig. 46.

LESSON 9.

Tools used.---*Bevel*, *Screw Driver*, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane.

New Tool Manipulations.—*Use of bevel, use of screw-driver, sawing through a face obliquely to the grain.*

The Bevel.—This tool (Fig. 47), like the try-square, consists of a stock made of hard wood, and a steel blade with parallel edges. But, unlike the blade of the try-square, the blade of the bevel can be adjusted at any angle to the stock. It is used for drawing lines inclined at different angles to an edge. The blade of the bevel has a slot in it.

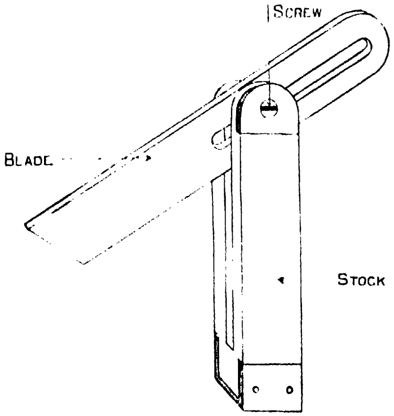


Fig. 47.

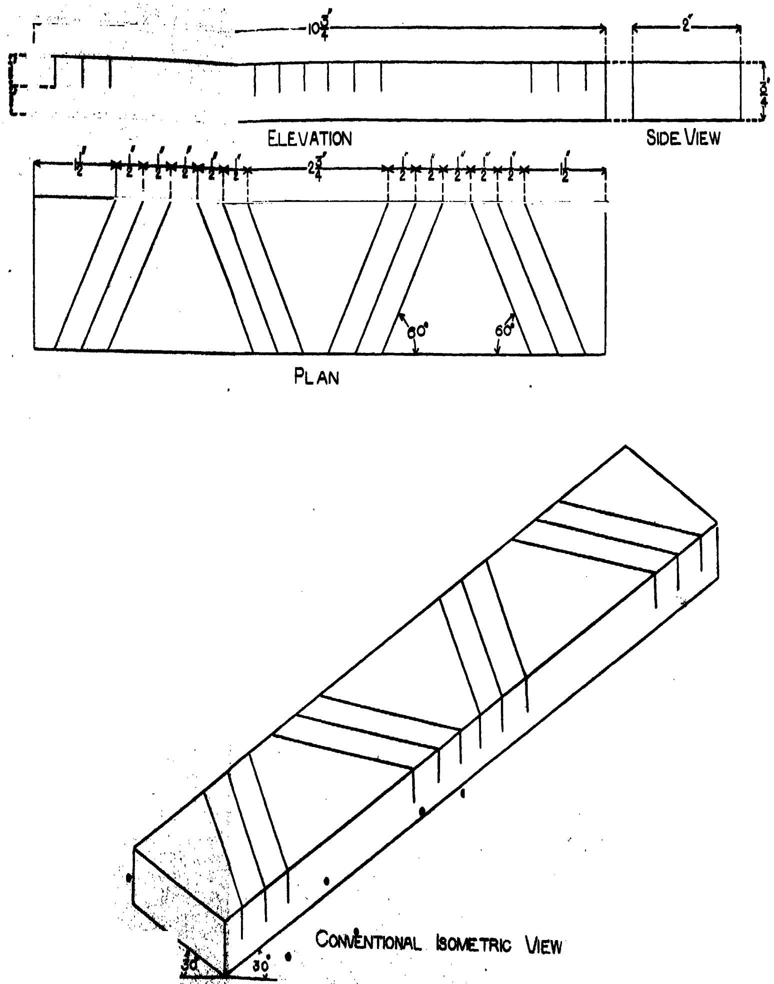

10 3/4"
2"
3/4"
ELEVATION
SIDE VIEW
1 1/2"
1/2"
2 3/4"
1 1/2"
60°
60°
PLAN
CONVENTIONAL ISOMETRIC VIEW
30°
30°

Fig. 49.

By loosening the screw at the end of the stock the blade can be adjusted to any angle, with the screw in any position of the slot. When the adjustment has been made the screw should be tightened so that the stock will grip the blade firmly enough to prevent it moving.

Screw Driver.—The shape of this tool is shown in Fig. 48. It consists of a handle made of hard wood, and a steel blade. It is used for driving in screws. The blade is shaped like a wedge so that it will fit into the groove on the head of the screw. The screw is loosened or tightened by turning the handle of the screw driver and at the same time applying a vertical downward pressure.

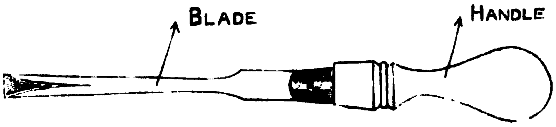


Fig. 48.

For particulars regarding the sharpening of the screw driver, see the Appendix.

Exercise 6.—*Rectangular prism with oblique saw cuts.*

You are given a piece of wood about 12″ × 2¼″ × 1″ and are required to make from it a rectangular prism with saw cuts inclined at 60° to the edges (Fig. 49). Make sketches of the class model and then make working drawings. (Fig. 49).

Make a rectangular prism of dimensions 10¾″ × 2″ × ¾″. Using the try-square and pencil, mark points along one edge of the prism at distances 1½″, 2″, 2½″, 3″, 3½″, 4″ from each end. These marks give the positions on the edge from which inclined lines will be drawn on the wood. Loosen the screw of the bevel. In doing this the bevel should be placed flat on the bench and the screw driver held vertically (Fig. 50).

Fig. 50.

Set the bevel to an angle of 60° by means of the set-square (Fig. 51).

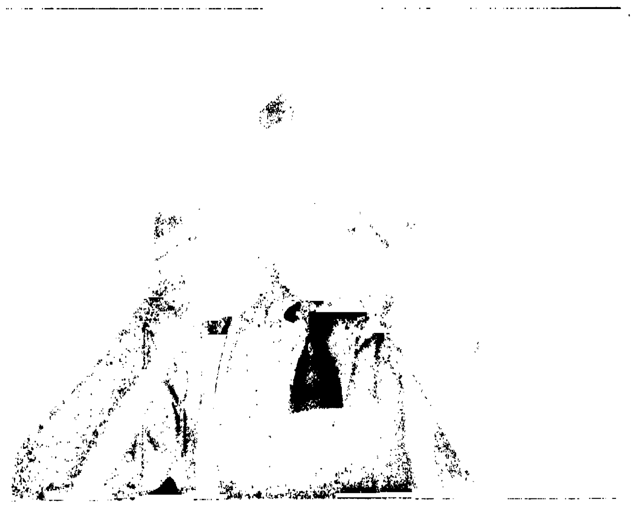


Fig. 51.

Now draw the inclined lines from the points on the edge by means of the bevel and marking knife, the bevel being used like the try-square. Go over the lines with pencil. Using the marking gauge, draw a line along the middle of each edge, and draw from the points on the edges vertical lines, by means of the try-square and marking knife, to meet this line. Go over these vertical lines with pencil. Place the prism horizontally in the vice and saw along the inclined lines down to the lines gauged on the edges.

LESSON 10.

Tools used.—*Firmer Chisel*, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane.

New Tool Manipulation.—*Horizontal chiselling across the grain.*

The Firmer Chisel.—This consists of a steel blade fitted into a wooden handle (Fig. 52). The blade thins towards the end, which is shaped like a wedge, and is used for paring wood, when the plane could not be conveniently used.

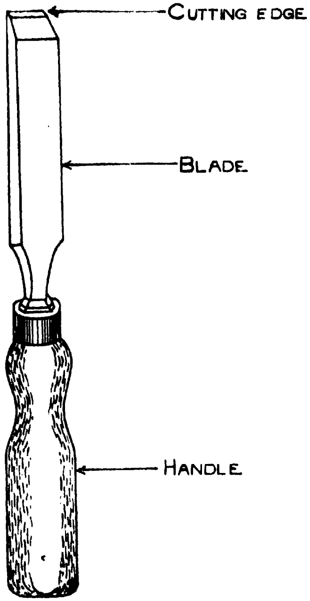


Fig. 52.

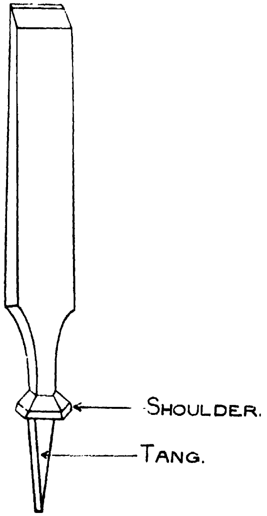


Fig. 53.

The teacher will separate the handle of a chisel from its blade and show you the "tang" (Fig. 53) which keeps the blade from turning in the handle, and the shoulder which prevents the handle from splitting when it is struck a blow with the hammer. For particulars regarding the sharpening of chisels, see the Appendix.

Exercise 7.—*Wooden Pattern* (*a*).

Make sketches of the class model and then make working drawings (Fig. 54.)

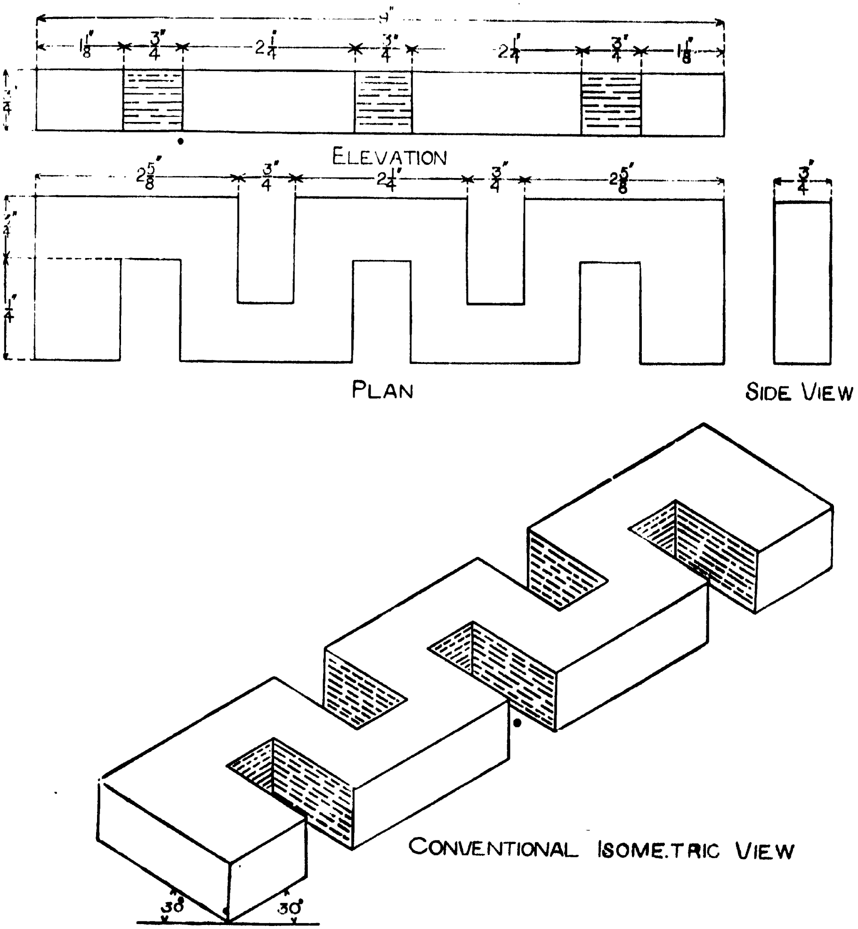


Fig. 54.

You are given a piece of wood about 12″ × 2¼″ × 1″. Make from it a rectangular prism of dimensions 9″ × 2″ × ¾″. Using the marking gauge, draw a line on the face side at a distance of 1¼″ from the face edge. Draw another line similarly on the opposite face. These lines give the depth of the three vertical cuts through the face edge.

Now draw on each face two lines at a distance of ¾″ from the face edge. These lines give the depth (1¼″) of the two cuts through the other edge

Using the try-square and marking knife, mark out on the two faces of the wood and on one edge the outline of the three cuts through the face edge. Similarly mark out the two cuts through the other edge. Go over all these lines with the pencil.

Place the wood in the vice and saw along these lines to the required depth. The cuts with the saw must be made so that the " clearance " will be entirely in the wood which is to be removed.

The rectangular portions of wood between the saw cuts must now be removed by means of the firmer chisel. The wood should be firmly fixed in the vice (Fig. 55.)

Fig. 55.

Hold the chisel, sloping slightly towards the handle with the bevelled edge uppermost; the right hand should grasp the handle and the left should grasp the blade (Fig. 55).

Remove the wood by pushing the chisel steadily forward. Cut off thin pieces of wood at a time, and be careful to keep the left hand away from the cutting edge.

In removing the wood cut away more from one side than from the other; thus, when you have got down to the gauged line on one side the wood will slope up from the line to the other side as shown in the sketch (Fig. 56). Turn the wood round and cut from the other side. Finally make the bottom of the groove flat by paring with the chisel held *horizontally* by the right hand and guided by a finger of the left hand.

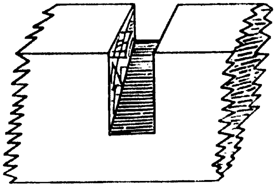


Fig. 56.

LESSON 11.

Tools used. —Firmer Chisel, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane, Bevel, Screw Driver.

New Tool Manipulation. —*Horizontal chiselling obliquely to the grain.*

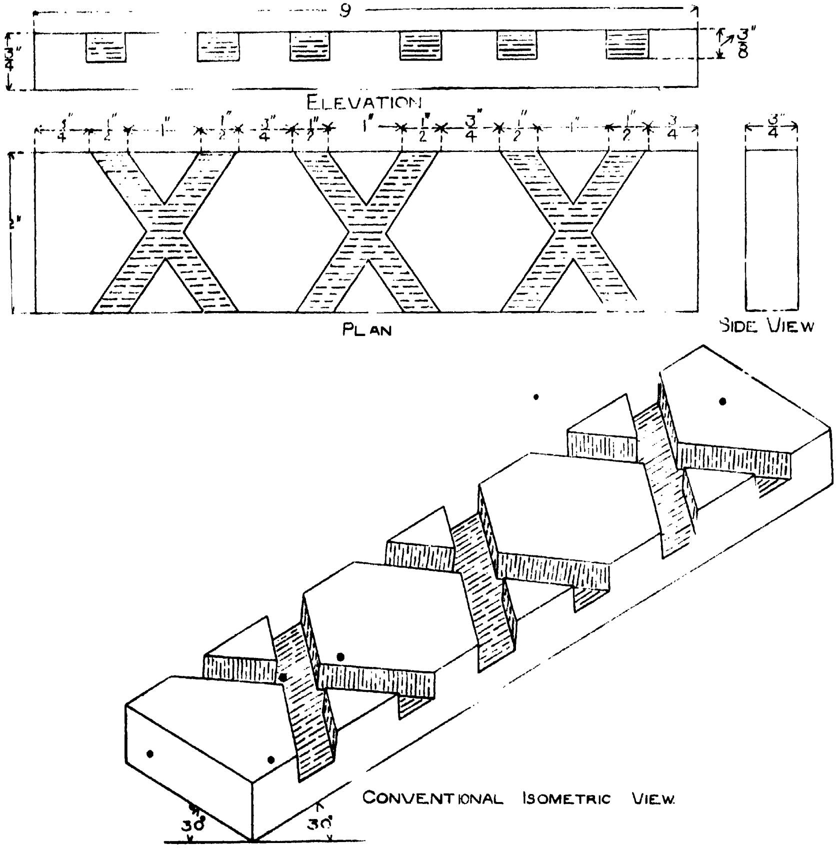


Figure 37.

Exercise 8. *Wooden Pattern (b).*

Make sketches of the class model and then make working drawings (Figure 57).

You are given a piece of wood about 12″ × 2¼″ × 1.″ Make from it a rectangular prism of dimensions 9″ × 2″ × ¾.″ By means of the bevel, marking knife, pencil, and marking gauge, draw the outline of the oblique cuts; in doing this, proceed as in Exercise 6, but work to the dimensions shown in your drawings.

Saw along the pencil lines to the depth of the lines gauged on the edges. Now chisel out the waste wood as in Exercise 7; you will have to use a chisel smaller than the one used in that exercise.

Figure 58 shows the position of the hands during the process of chiselling. It will be seen from the figure that the fingers are protected from the edge of the chisel by the wood; nevertheless great care must be taken that the chisel does not slip and cut the fingers.

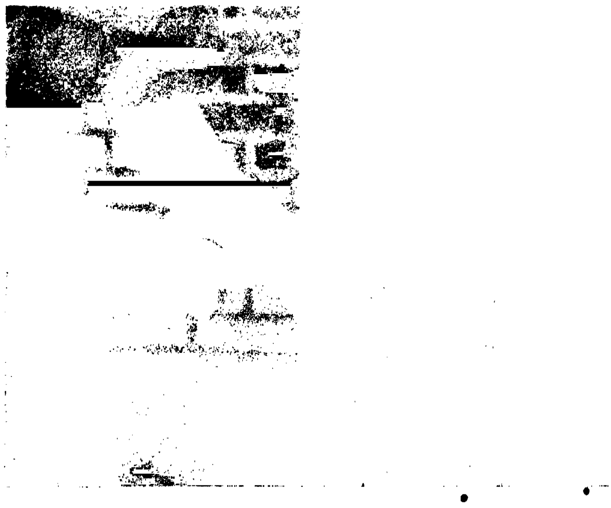


Fig. 58.

LESSON 12.

Tools used.—Firmer Chisel, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane, Bevel, Screw Driver.

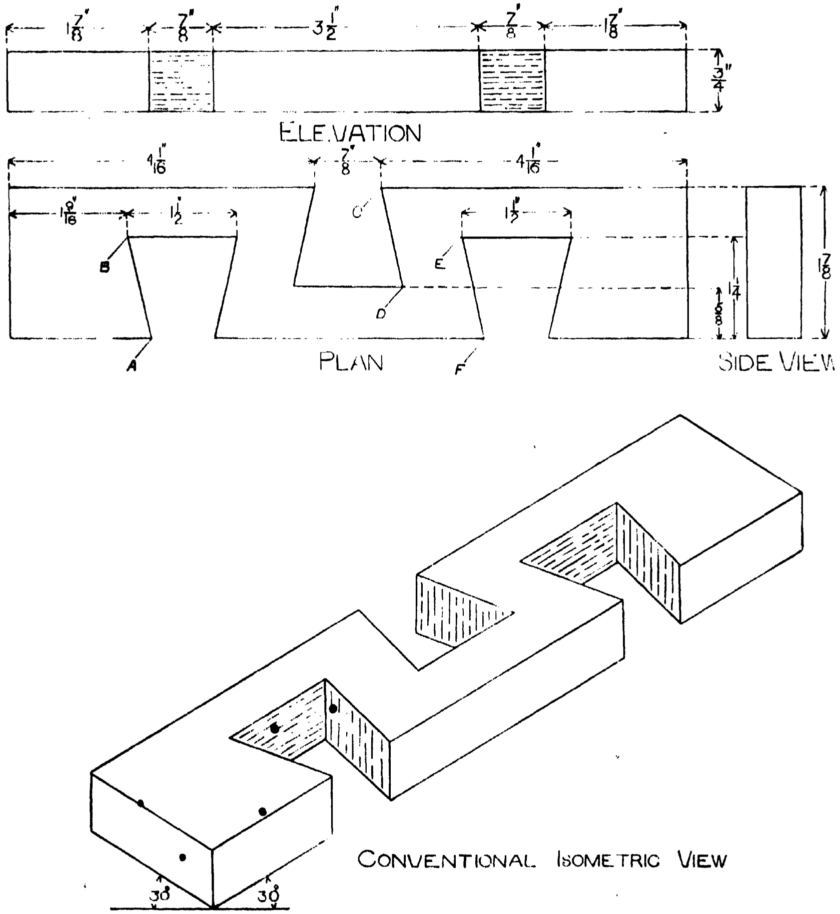


Fig. 59.

Exercise 8. *Wooden Pattern (b).*

Make sketches of the class model and then make working drawings (Figure 57).

You are given a piece of wood about 12″ × 2¼″ × 1.″ Make from it a rectangular prism of dimensions 9″ × 2″ × ¾.″ By means of the bevel, marking knife, pencil, and marking gauge, draw the outline of the oblique cuts ; in doing this, proceed as in Exercise 6, but work to the dimensions shown in your drawings.

Saw along the pencil lines to the depth of the lines gauged on the edges. Now chisel out the waste wood as in Exercise 7 ; you will have to use a chisel smaller than the one used in that exercise.

Figure 58 shows the position of the hands during the process of chiselling. It will be seen from the figure that the fingers are protected from the edge of the chisel by the wood ; nevertheless great care must be taken that the chisel does not slip and cut the fingers.

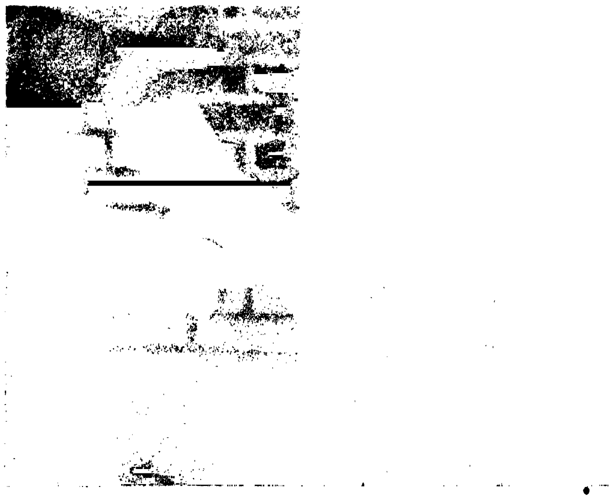


Fig. 58.

Saw through the edges along the lines which mark the boundary of the cuts. In doing this do not hold the saw vertically, but inclined to the edge of the wood at the same angle as the lines. Place the wood in the vice as in Exercise 7, and remove most of the waste wood by horizontal chiselling, first using a narrow chisel and then a wider one as the opening gets larger. When nearly all the waste wood has been removed lay the wood flat on the bench hook (Fig. 60).

Holding the chisel vertically by the first two fingers and the thumb of the left hand, as shown in the figure, remove a small piece of wood at a time until the gauged line is reached.

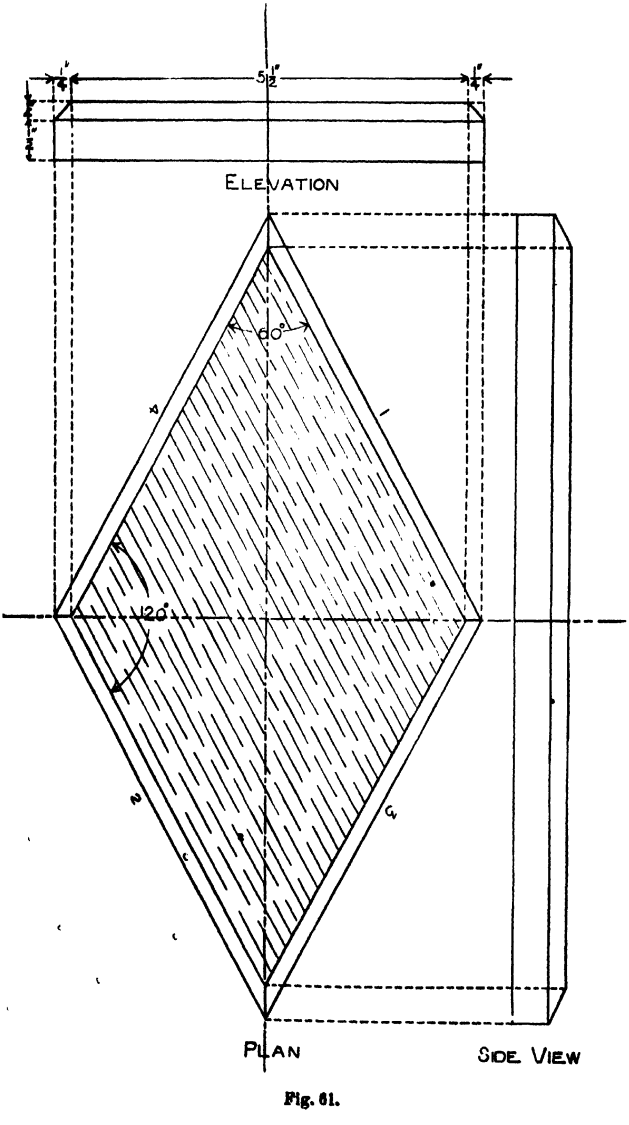


Fig. 61.

LESSON 13.

Tools used.—Firmer Chisel, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane, Bevel, Screw Driver.

New Tool Manipulations.—*Chamfering with plane with the grain, chamfering with chisel across the grain.*

Exercise 10.—*Rhombus with chamfered edges.*

Make sketches of the class model. Notice that in plan the model is a *rhombus*, that is a parallelogram with four equal sides. Notice too that the face side and the four edges do not meet in four lines but in four strips. These are called *chamfers.* They are surfaces which are equally inclined, at an angle of 45°, to the face side and edges. *Chamfering* is a simple means of ornamentation in wood-work.

Make the working drawings. (Fig. 61).

(You need not make a conventional isometric drawing.)

You are given a piece of wood $9\frac{1}{2}'' \times 5\frac{1}{2}'' \times 1''$. Notice carefully how the grain runs. Plane two sides and *one* of the edges parallel to the grain. With the bevel, mark out on the two planed sides and on the planed edge two lines at an angle of 60°, to the face edge and 6″ apart. (Fig. 62.)

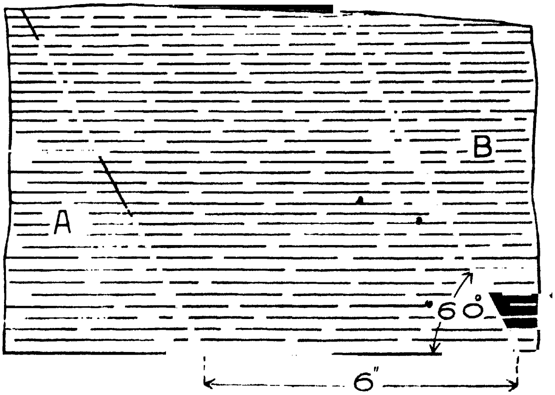


Fig. 62.

Saw off the waste wood A ; the saw should be made to move *in the waste wood* about $\frac{1}{8}''$ from the line drawn by the bevel. Similarly saw off the waste wood B. Remove the small portions of waste wood, left after sawing, by planing down to the lines with the jack plane. Now you have a piece of wood shaped like that shown in Fig. 63.

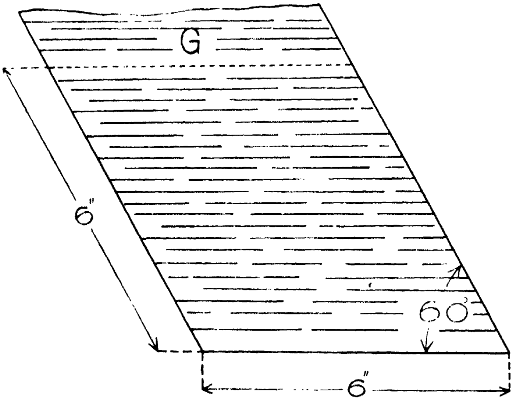


Fig. 63.

To complete the rhombus draw a line on both sides of the wood ; this line is shown dotted in the figure. Plane off the piece G. The piece of wood is now, in plan, a *rhombus.*

The chamfering of the four edges of the face side still remains to be done. First mark out four lines on the face side, each being at a distance of $\frac{1}{4}''$ from the line in which the corresponding edge meets the face side. Then draw four lines on the four edges, each of these also being at a distance of ¼″ from the line in which the face side meets the edge. These lines are shown dotted in Fig. 64.

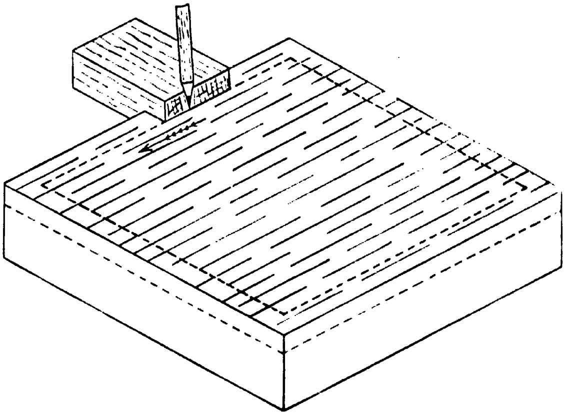


Fig. 64.

The lines are drawn by the *thumb gauge* (Fig. 65.)

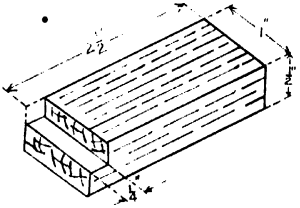


Fig. 65.

The thumb gauge is a small piece of wood, with at one end a notch of the depth (¼″) of the chamfer. Each pupil should make his own thumb gauge from teak wood. In using the thumb gauge fix the wood vertically in the vice. Place the point of the pencil in the angle formed by the thumb gauge and the face side, and, holding the pencil nearly at right angles to the face side, draw the *gauge and pencil together* along the wood. Fig. 64 shows the position of the wood, gauge, and pencil. In this way draw all the lines on the face side and edges. The thumb gauge is used in preference to the marking gauge, as the spur of the latter would make a vertical cut into the wood, and so would prevent a clean intersection being made between the chamfer and the face side and edges.

To chamfer the two edges parallel to the grain, i.e., edges (1) and (2) of the plan (Fig. 61), use the smoothing plane. Place the wood in the vice, and holding the plane at 45° to the face side (Fig. 66) plane in the direction of the grain until you reach the two boundary lines of the chamfer. While planing you should take strokes which go the whole length of the wood and should hold the plane so that the two boundary lines are reached at the same time; the plane should be guided by the left hand which should also keep it pressed down on the wood.

Fig. 66.

To chamfer the two edges across the grain, i.e., edges (3) and (4) of the plan (Fig. 61), place the wood in the vice and remove thin shavings by means of the ¾″ firmer chisel. Fig. 67 shows how the chisel should be held. The cut should be commenced with the right hand corner of the edge of the chisel, which should be pushed forward by one hand, while the other hand should gradually push the blade across the wood until the left hand corner of the edge is reached. Continue removing a little wood with each stroke until the chamfer boundary lines are reached.

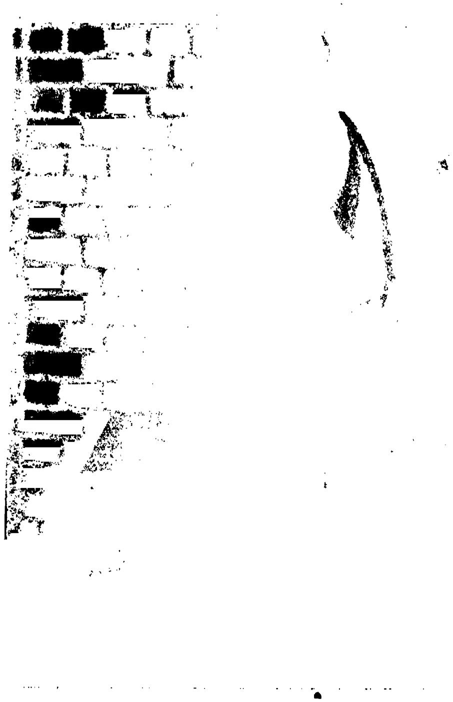


Fig. 67.

LESSON 14.

Tools used.—*Trying Plane, Hammer, Mallet,* Firmer Chisel, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane, Bevel, Screw Driver.

New Tool Manipulations.—*Vertical chiselling obliquely to the grain, inlaying.*

Trying Plane.—Fig. 68 shows the shape of the cutting iron of the Jack Plane.

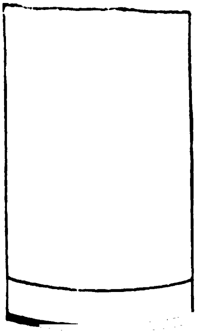


Fig. 68.

It is obvious from the shape of this iron that a Jack Plane cannot produce a perfectly smooth surface ; the plane will make in the surface a number of very shallow grooves as shown in Fig. 69.

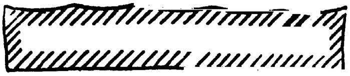


Fig. 69.

The *Trying Plane* differs from the Jack Plane chiefly in having a cutting iron shaped like that in Fig. 70.

It is therefore possible to produce by means of it a more true surface than when the Jack Plane is used. Also the Trying Plane usually has a longer body and a wider iron than the Jack Plane; it is therefore more reliable than the latter in removing irregularities from the surface of the wood. It is used for finishing wood which has been planed first by the Jack Plane. Its iron should never be set at more than $\frac{1}{32}''$. In the following and all future Exercises you should finish the smoothing of surfaces with the Trying Plane, after the Jack Plane has been used.

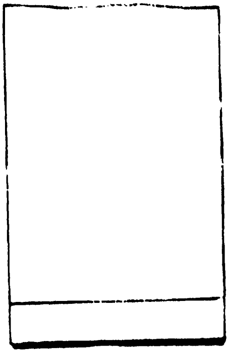


Fig. 70.

The Hammer.—This is shown in Fig. 71. The head is of iron, and is used generally for driving in nails. In a good hammer the head is well-balanced on the handle, which should be about a foot long, and so shaped that it is easily grasped by the hand.

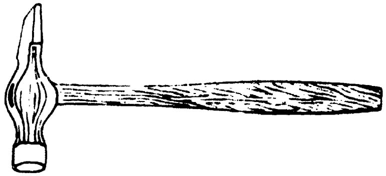


Fig. 71.

The Mallet.—This is a hammer with a large wooden head (Fig. 72). Its blow is not as sharp as that of a hammer with an iron head, and so it is used for striking things which would be injured by an ordinary hammer, *e.g.*, the wooden handle of a chisel.

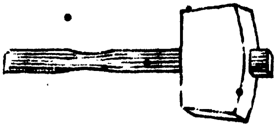


Fig. 72.

Exercise 11.—*Rectangular Prism with Inlaid pieces.*

Make sketches of the class model, and then make working drawings (Fig. 73).

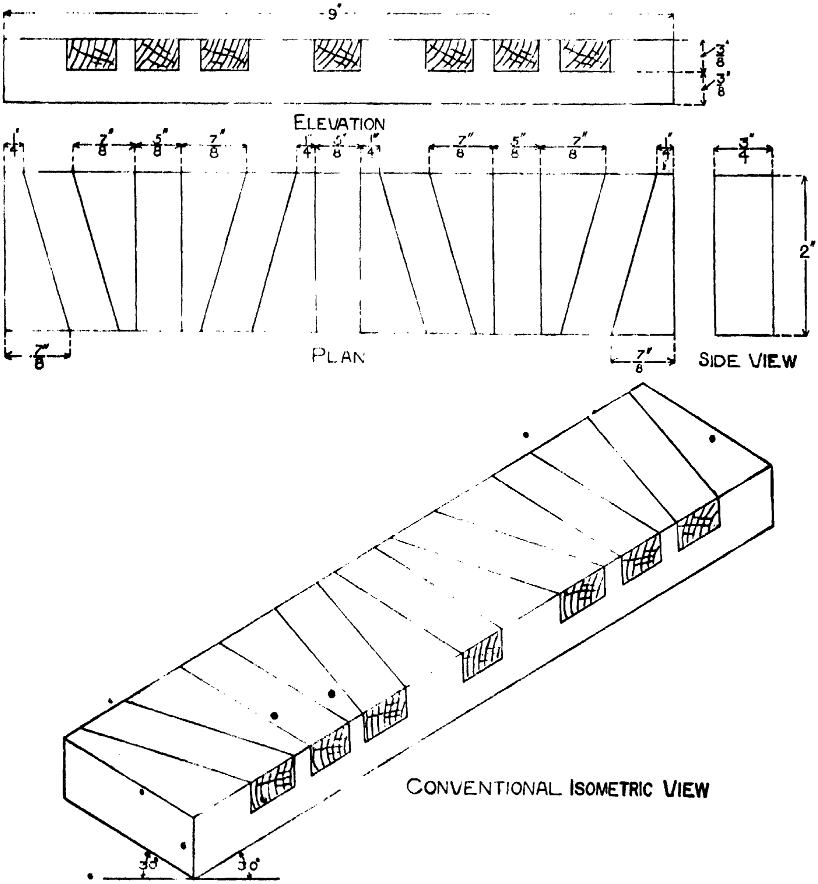


Fig. 73.

You are given a piece of wood $9\frac{1}{2}''\times 2\frac{1}{4}''\times 1.''$ Make a rectangular prism of dimensions $9''\times 2''\times \frac{3}{4}.''$

Using the bevel and rule, mark out the position of the grooves in the wood. For the three grooves which are perpendicular to the edges of the prism proceed as in Exercise 7 ; first saw along the boundary lines of the groove (keeping the " clearance" of the saw in the waste wood) to a depth of $\frac{3}{8},''$ and then chisel out the waste wood by horizontal chiselling.

In the case of the four oblique cuts do not saw along the boundary lines, but about $\frac{1}{8}''$ inside them, and chisel out (as in Exercise 8) the waste wood between the saw cuts nearly down to the lines gauged on the edges. In order to remove the remaining waste wood (A and B, Fig. 74) proceed as follows :—

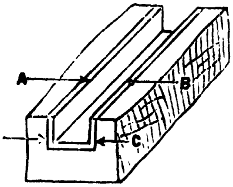


Fig. 74.

Place the wood vertically in the vice, and, using the chisel and mallet, deepen the boundary lines C which are marked on the edges. Now place the wood horizontally in the vice, and, using the chisel (with 1" blade) and mallet as in Fig. 75, chisel out the remainder of the waste wood A and B. Now finish the groove by chiselling out horizontally down to the lines gauged on the edges.

From *tun* wood (or any other dark wood) make a rectangular prism about 8" in length, and a little more than $\frac{3}{8}''$ in thickness and $\frac{5}{8}''$ in breadth. It is very important that the face side of this prism should be exactly at right angles to the two edges ; the face side and two edges will then fit the grooves. From the prism cut off pieces about 2" long, and, by gradually reducing their breadth by the smoothing plane, fit them into the three grooves which are at right angles to the edges. The fitting should be very accurate, and should be made by taking off small shavings, trying the fit, reducing the breadth a little more, and so on, until an exact fit is obtained. A few taps from the hammer may be necessary in order to drive the pieces home into the grooves. This process is called *inlaying.*

Fig. 75.

Make another similar prism of length about 10″ and from it cut off pieces and insert them in the oblique grooves.

Saw off the projecting ends of the inlaid pieces, and smooth the edges of the prism with the smoothing plane. Finally smooth the surfaces of the inlaid pieces down to the level of the face of the prism by using the smoothing plane; the pieces should be planed down one after another, the planing being parallel to their length.

LESSON 15.

Tools used.—Firmer Chisel, Jack Plane, Try-square, Marking Knife, larking Gauge, Tenon Saw, Smoothing Plane, Trying Plane, Mallet.

New Tool Manipulations.—*Vertical chiselling at right angles to the rain, horizontal chiselling with the grain.*

You have now had sufficient practice with various tools to enable ou to make useful things. You will go on learning the further uses to vhich these tools can be put, and also the uses of other tools; but as far s possible you will learn new manipulations in making things which you an put to use in your homes.

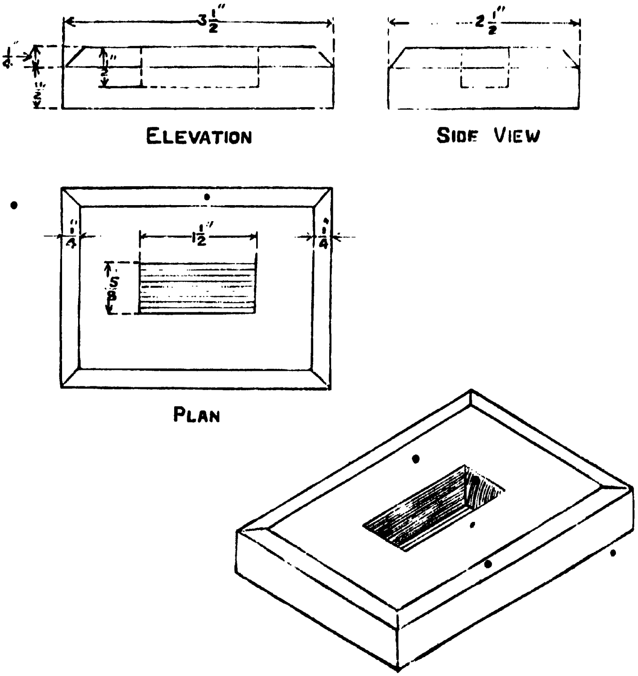


Fig. 76.

Exercise 12.—*Match Box Holder.*

Make sketches of the class model and then make working drawings. (Fig. 76).

You are given a piece of wood 4″×3″×1″. Make a rectangular prism of dimensions $3\frac{1}{2}''\times2\frac{1}{2}''\times\frac{3}{4}''$.

Mark out the position of the chamfers by means of the thumb gauge as in Exercise 10. Mark out the position of the rectangular hole in the centre by means of the marking gauge. Fix the wood horizontally in the vice. Using the chisel and mallet, mark out the boundary of a rectangle whose sides are about $\frac{1}{16}''$ inside the sides of the rectangle which was drawn by the marking gauge. The dotted lines in Fig. 77 show the lines thus cut by the chisel. In doing this hold the chisel vertically by the left hand with its bevelled edge away from you; the long sides of the rectangle should be cut with the $\frac{3}{4}''$ or 1″ chisel, and the short ones with the $\frac{1}{2}''$ chisel.

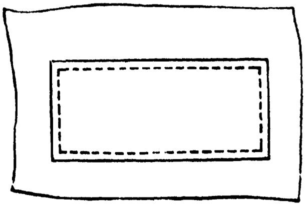


Fig. 77.

You will now chisel out the wood inside the inner rectangle. Fig. 78 shows how the chisel and mallet should be held in doing this. The chisel is held in the left hand, and sloping, as shown in the figure, with the bevelled edge on the side away from the body. You will find it convenient first to chisel wood from one end of the rectangle, and then to go to the other end of the vice and chisel from the other end of the rectangle.

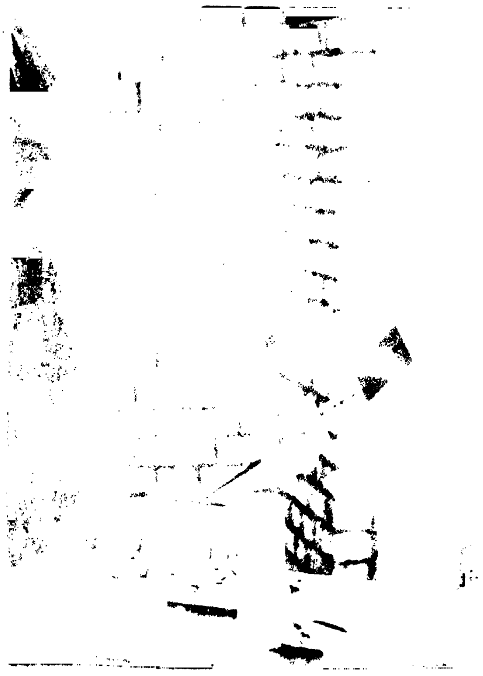


Fig. 78.

When you have in this way chiselled out wood to the depth of the boundary cuts forming the inner rectangle, deepen these cuts still more and chisel out again. Continue this process of deepening the boundary cuts and chiselling until you reach to a depth of $\frac{7}{16}$". By vertical chiselling remove wood from the sides of the hole until you reach the gauged lines. Finally remove the extra $\frac{1}{16}$" of wood at the bottom, so that you may have a hole exactly of the dimensions given in the drawing. In removing the last $\frac{1}{16}''$ of wood from the bottom of the hole it will be better

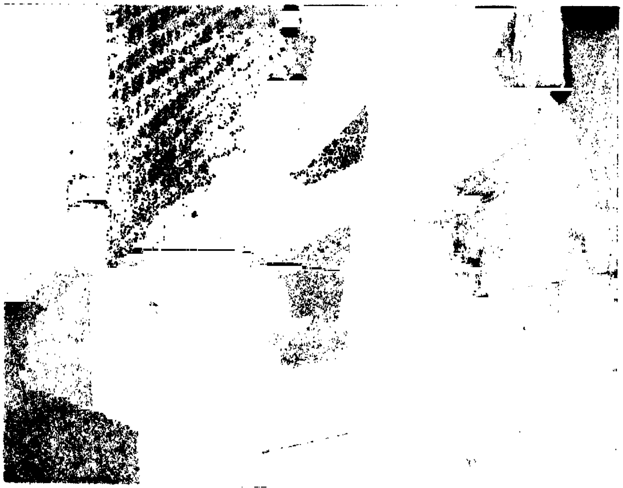


Fig. 79.

to dispense with the mallet and use the chisel as a scraper. Fig. 79 shows the position of the hands and the chisel in this final operation.

LESSON 16.

Tools used.—Firmer Chisel, Jack Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Bevel, Screw Driver, Smoothing Plane, Mallet, Hammer, Trying Plane.

In the following Exercise there are no new tool manipulations to learn, but further practice is given in the important manipulations learnt in Exercises 11 and 12, namely chiselling and inlaying.

Glass Paper.—This consists of paper with a coating of powdered glass glued to it. It is used for finishing surfaces which cannot easily be finished by the smoothing plane. It can be purchased in several degrees of fineness, varying from "0," which is very fine, to "2½" which is coarse. The most convenient size for ordinary wood is "1." The best method of using glass paper is to stretch it across the surface of a small block of wood; it should be moved *with the grain.*

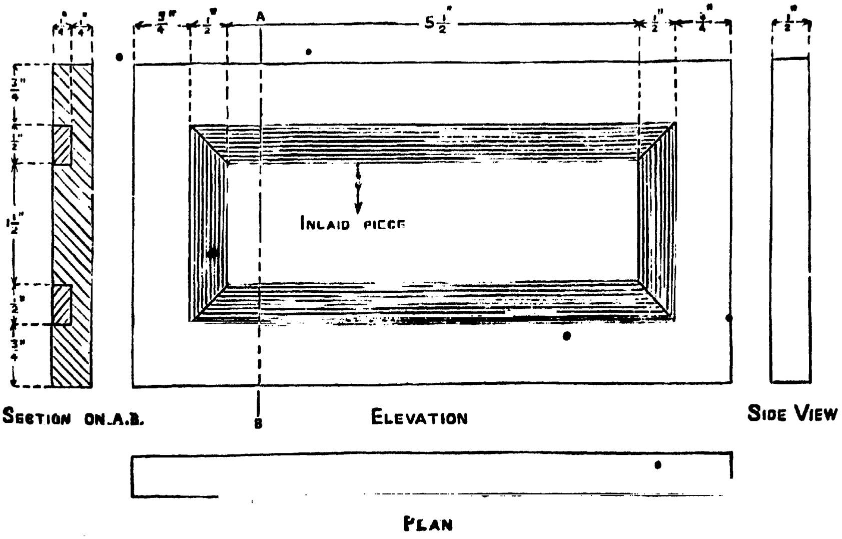


Fig. 80.

Exercise 13.—*Name Board.*

Make sketches of the class model and then make working drawings. (Fig. 80.)

These drawings include a *section* through AB, *i.e.*, a drawing showing the appearance of the wood which would be exposed by a cut through AB.

You are given a piece of wood about 8½″ × 4½″ × ¾″. Make from it a rectangular prism 8″ × 4″ × ½″. Mark out with the marking gauge the positions of the grooves for the inlaid pieces. Chisel out the grooves in the manner in which the groove for the match box was made in Exercise 12.

From *tun* wood, or any other dark wood, cut two rectangular prisms of length 6½″, of width a little more than ½″, and of depth a little more than ¼″. By means of the bevel mark the lines AB, CD (Fig. 81) at 45° to AC.

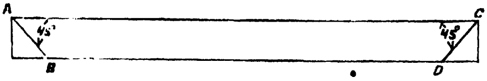


Fig. 81.

Saw along these lines, making the 'clearance' of the saw lie in the waste wood. Now fit the pieces into the long grooves. You may do this by using the smoothing plane to reduce them to the exact size required. For very accurate work, however, you should use glass paper instead of the smoothing plane in the final stages of fitting. Similarly prepare pieces for the shorter sides of the inlaid rectangle, and fit these into the corresponding grooves.

Finally, plane down the surfaces of the inlaid pieces to the level of the surface of the rectangular prism.

LESSON 17.

Tools used.—*Bradawl, Nail Punch,* Firmer Chisel, Jack Plane, Trying Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Bevel, Screw Driver, Smoothing Plane, Hammer.

New Tool Manipulations.—*Boring with bradawl, nailing.*

Bradawl.—This tool is shown in Fig. 82. It consists of a steel blade A and a wooden handle B.

It is used for making holes in wood for the insertion of small nails; these holes save labour in hammering the nails, and, by providing a way into the wood for the nails, they prevent the latter being bent when they are driven into the wood. It will be seen that the bradawl has a small chisel edge; it should therefore be placed *across* the fibres of the wood when it is driven in, so that it will cut these.

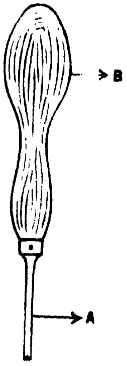


Fig. 82.

Nail Punch.—It is often desirable to sink the heads of nails below the surface of wood. The *nail punch* is used for this purpose. It consists of a piece of steel (Fig. 83) about 3½″ long, tapering to a rectangular or circular end.

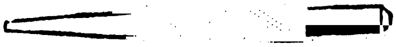


Fig. 83.

After the nail has been driven into the wood the nail punch is placed on the head of the nail and hammered until the head is driven below the surface.

Nails.—The most common kinds for Manual Training work are shown in Fig. 84.

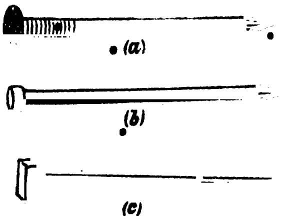


Fig. 84.

(*a*) and (*b*) are the most useful. Both are made from wire and so are called *wire nails*; the section of (*a*) is circular, and of (*b*) oval. Owing to their sharp points they are easily inserted in wood, without risk of splitting it. The nail (*c*), called the *cut brad*, is also useful in light wood work.

Exercise 14.—*Stool.*

Make sketches of the class model and then make working drawings (Fig. 85).

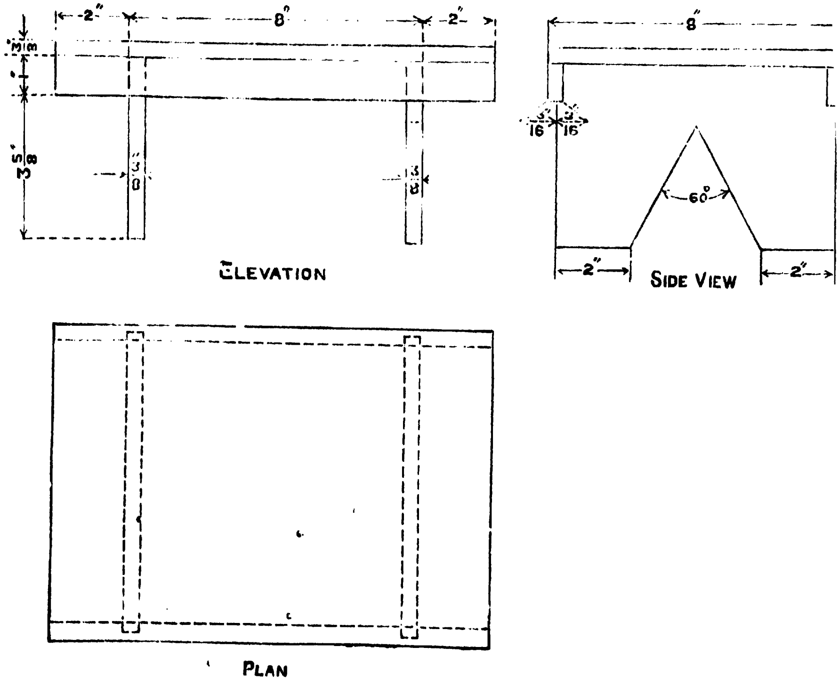


Fig. 85.

Make 5 rectangular prisms of dimensions as follows:—

One prism 12″ × 8″ × ⅜″ (for the top of the stool).
Two prisms, each 12″ × 1″ × ⅜″ (for the sides of the stool).
Two prisms, each 4⅝″ × 7⅝″ × ⅜″ (for the legs of the stool).

From the last two prisms, using the bevel and tenon saw, shape the legs as shown in Fig. 86; in cutting out the triangular piece see that the clearance of the saw is in the waste wood.

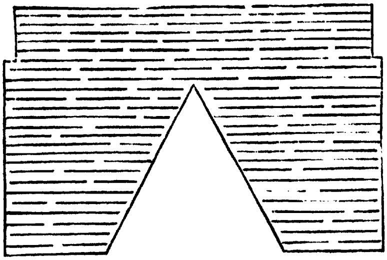


Fig. 86.

You will now fit the pieces of the stool together.

Place the two side pieces together and mark on them two lines A, A^1, at a distance of 2″ and 2⅜″ respectively from one end. (Fig. 87).

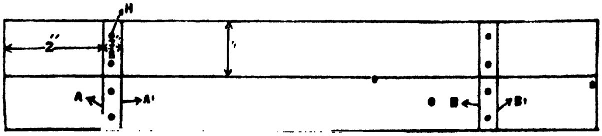


Fig. 87.

These give the position of one leg. Similarly mark out the position for the other leg, by lines B, B^1, at distances of 2″ and 2⅜″ respectively from the other end.

On each piece of wood mark with pencil the positions at which holes should be bored by the bradawl for nails. The positions of these holes are shown, (H), in Fig. 87; they lie mid-way between the lines.

To bore the holes with the bradawl place the piece of wood on the bench hook (Fig. 88). Hold the bradawl vertical, with the cutting edge

Fig. 88.

at right angles to the grain of the wood, and push the tool steadily forward, twisting alternately slightly to the right and left.

Place one of the legs vertically in the vice and bore the corresponding holes in this leg with the bradawl (Fig. 89); the sum of

Fig. 89.

the lengths of the two holes bored by the bradawl should be less than the length of the nail to be used. Similarly bore holes in the other leg.

Now fix one side piece to the legs with nails. To do this hold the nail (Fig. 90) between the finger and thumb of the left hand and grasp the hammer in the right hand at the end of the handle. Cause the nail to enter the wood by a tap from the hammer; then remove the fingers and, by a succession of steady blows, drive the nail home.

Fig. 90.

Turn the partly completed stool so that it lies on the bench with the fixed side piece underneath; nail on the other side piece.

Draw lines with pencil on the face side of the top piece (Fig. 91).

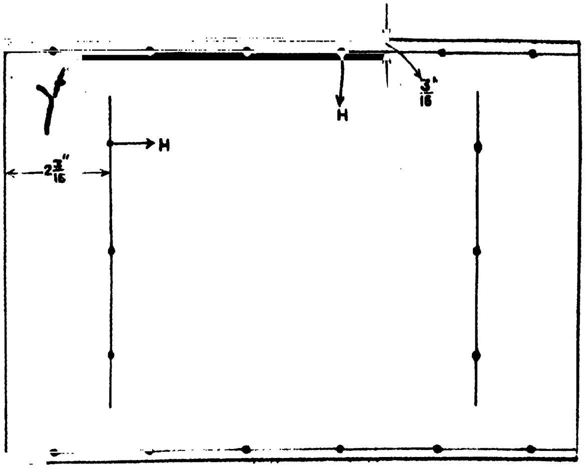


Fig. 91.

These lines give the positions for lines of nails fastening the top to the sides and legs respectively. The figure shows the positions at which holes, H, for the nails should be bored on these lines. Bore these holes in the top piece, and at the same time the corresponding holes in the side pieces and legs. Nail down the top piece.

Using the nail punch drive the heads of all nails just below the surface.

LESSON 18.

Tools used.—*Compass*, *File*, Jack Plane, Trying Plane, Smoothing Plane, Tenon Saw, Bevel, Screw Driver.

New Tool Manipulations.—*Use of Compass, modelling with Jack Plane, use of File.*

The Compass.—This tool is used for drawing circles on wood. A common form is shown in Fig. 92. This form is called the Wing Compass.

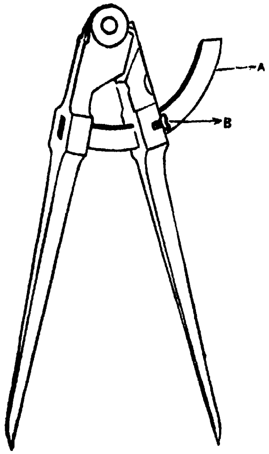


Fig. 92.

In one of the legs there is a slot through which passes the "wing" (A); the leg can be fixed to any position to this wing by means of the screw (B).

The File.—This tool consists of a steel blade on the surface of which very small ridges have been cut. At one end there is a "tang" which fits into a wooden handle. The common files used in Manual Training are the *flat* file, the *half-round* file, the *triangular* file, and the *circular* file. These are shown in Fig. 93.

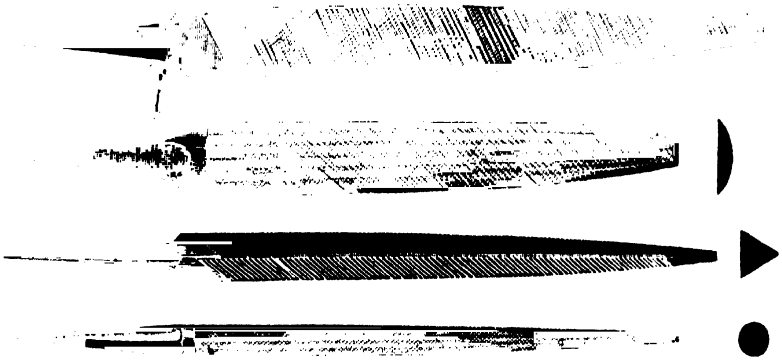


Fig. 93.

These names have been given to the files on account of the shapes of their *cross-sections*, which are also shown in the figure. A file is cleaned by dipping it in hot water, which loosens the sawdust, and then by drying and brushing it.

Exercise 15.—*Round Ruler.*

Make sketches of the class model and then make working drawings. (Fig. 94).

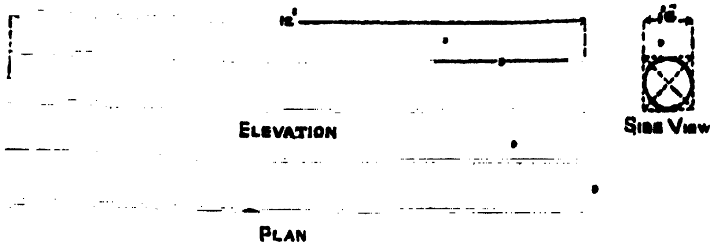


Fig. 94.

Make a square prism of length 12″, and with ends 1″ square. At one end draw the two diagonals (*a*) (Fig. 95).

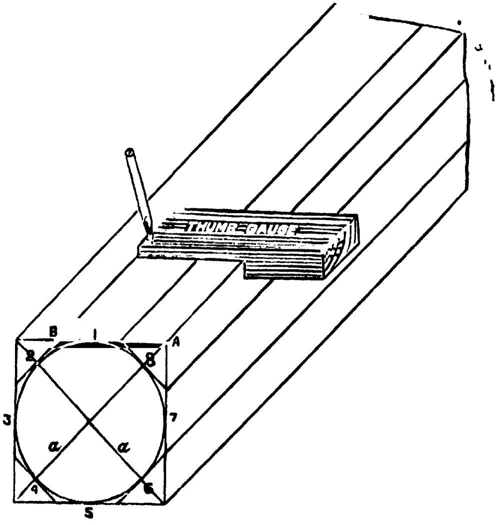


Fig. 95.

With the point of intersection of these diagonals as centre describe with the compass a circle touching the four sides of the square. With the bevel draw four tangents to this circle at the points where the diagonals cut it. To do this put the stock of the bevel against one side of the prism, and move the blade until its edge coincides with a diagonal. Tighten the screw and move the stock until the edge of the blade is a tangent to the circle; then draw the tangent. You thus get the eight sides (Fig. 95) of a regular octagon (*i.e.*, a figure with eight equal sides.)

Make a thumb gauge the depth of whose notch is equal to the length AB (Fig. 95), and draw lines on the sides of the prism through each of the angular points of the octagon (Fig. 95). Draw an octagon on the other end of the prism by joining the ends of the lines.

You have to make an octagonal prism by chamfering the edges of the square prism down to the lines drawn on its sides. This is done by means of the Jack Plane, and the process is called "modelling with the Jack Plane." It would be difficult to fix the prism in the vice for this process of modelling therefore you should adopt the following arrangement:—

Make two rectangular prisms A and B, about 11″ × 2″ × 1″, and chamfer one edge of each (Fig. 96.)

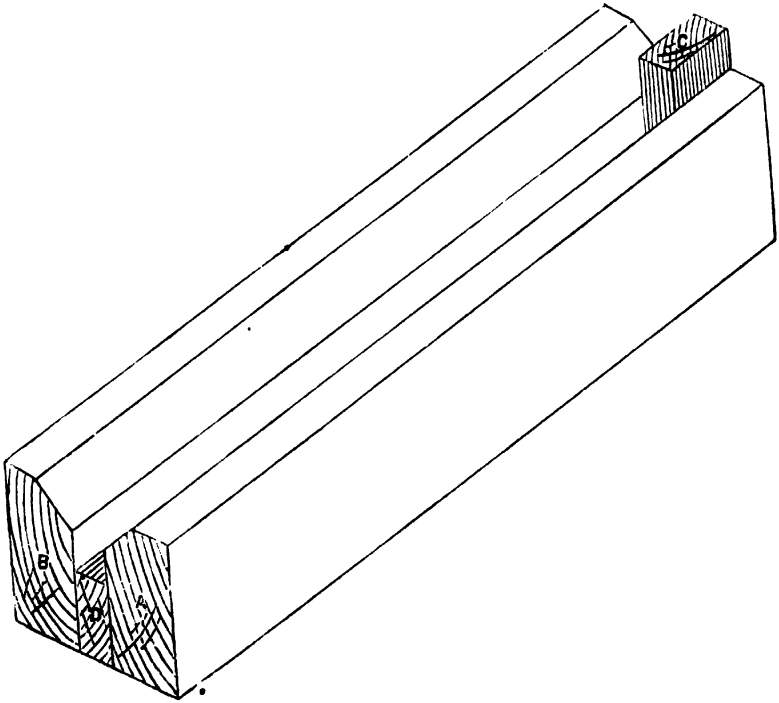


Fig. 96.

Place one block C (about 2½″ × ½″ × 1″) and another block D (about 1″ × ½″ × 1″) between the prisms, C to act as a stop and D to keep the prisms equally apart. Fix the prisms A and B in the vice, and place the square prism between the chamfered edges and against the stop C (Fig. 97).

Fig. 97.

Reduce the square prism to an octagonal prism by using the Jack Plane (Fig. 97). Now remove the angles of the octagonal prism one by one by means of the Smoothing Plane (Fig. 98). You will see from the

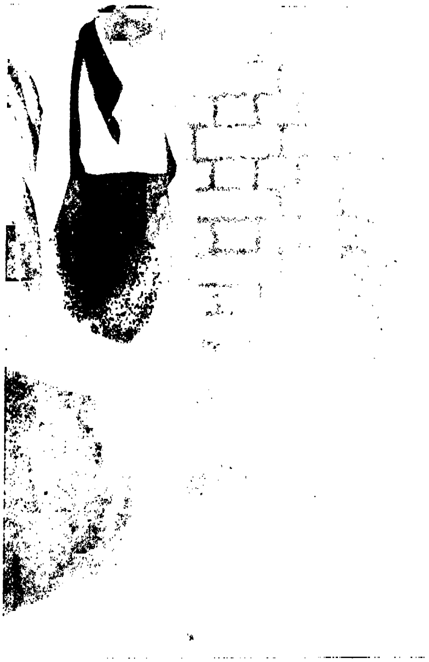


Fig. 98.

figure that the prism is turned by the fingers of the left hand in order to bring the edges to the top in succession.

The prism should now be made exactly circular by holding it in e left hand, as shown in Fig. 99, and, while turning it, pushing the half-round file forward with a steady pressure. The file on the back stroke should be allowed simply to glide over the surface of the wood.

Fig. 99.

LESSON 19.

Tools used.—*The Firmer Gouge*, Jack Plane, Trying Plane, Tenon Saw, Marking Gauge, Marking Knife, Compass, Try-square, Thumb Gauge, Bevel, Screw Driver.

New Tool Manipulations.—*Gouging, stop chamfering.*

Firmer Gouge.—This tool is shown in Fig. 100.

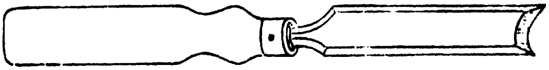


Fig. 100.

It is simply a chisel with a concave blade. The convex surface of the blade is ground to form the cutting edge. For particulars regarding the sharpening of the gouge, see the Appendix.

The Holdfast.—This is an appliance for clamping wood to the bench when it is required to hold it steadily in one position. One form (called the "G cramp") is shown in Fig. 101, and its use in Fig. 104.

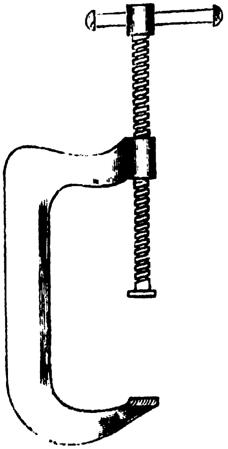


Fig. 101.

Exercise 16.—*Inkstand.*

Make sketches of the class model and then make working drawings ig. 102.) These drawings include a *section* through the pen-rest and ne ink-well.

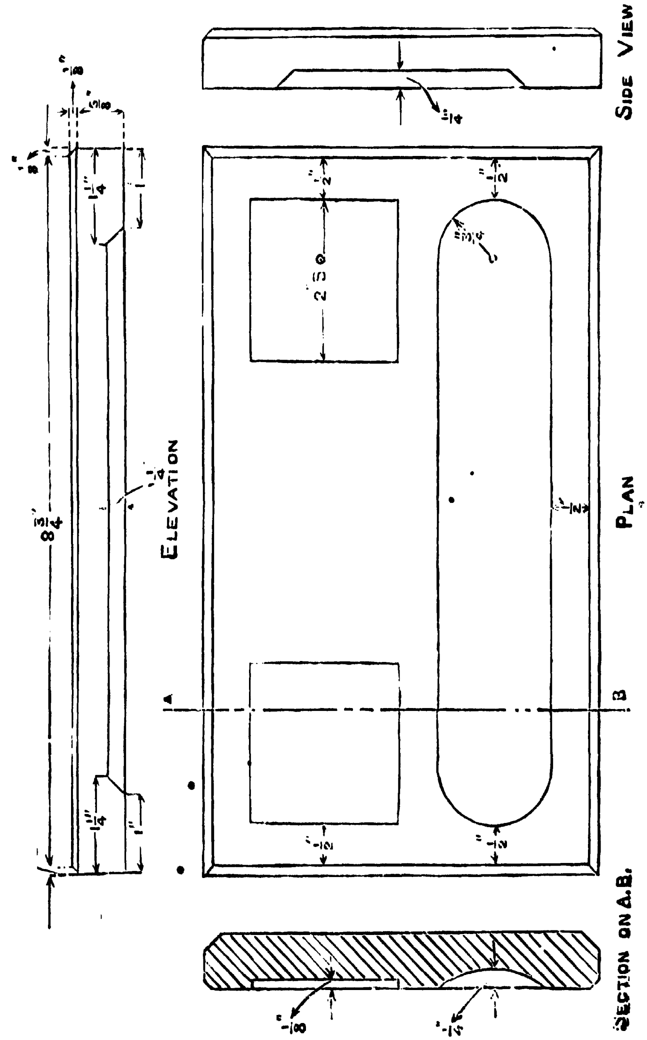


Fig. 102.

Make a rectangular prism of dimensions $9'' \times 5\frac{1}{4}'' \times \frac{3}{4}''$. On the face side and edges which meet it, mark lines with the thumb gauge for the chamfering of the upper edges of the stand. Draw on the face side the construction lines for the ink-wells and pen-rest (Fig. 103). The longitudinal lines should be drawn with the marking gauge and the lines at right angles to these with the try-square and marking knife. Using the bevel draw lines (*a*) (Fig. 103) at 45° to the longitudinal lines, and, with the point of intersection of these lines as centre, describe two semi-circles to form the ends of the boundary of the pen-rest. Go over all these lines with pencil.

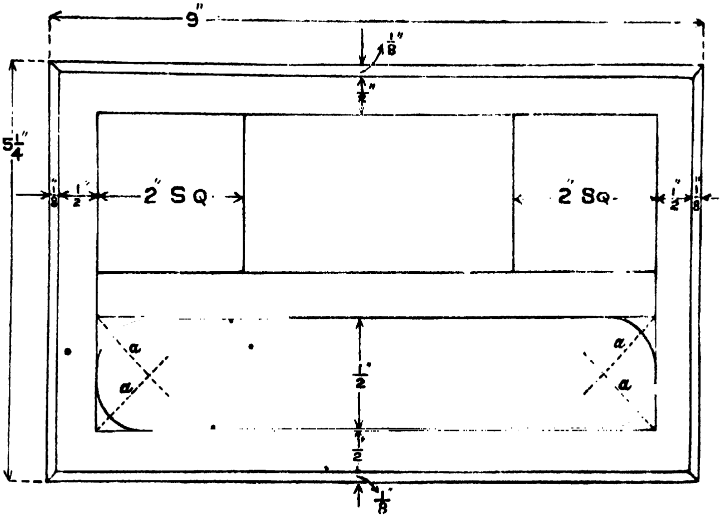


Fig. 103.

Make the grooves for the ink pots in the same manner as the groove for the match box was made in Exercise 12.

Fasten the prism to the bench by means of the holdfast (Fig. 104). You should place two small pieces of wood between the holdfast and the prism to prevent the latter being injured. Now form the pen-rest by scooping out wood with the gouge in the manner shown in Fig. 104. Use the thumb of the left hand to exert pressure with and guide the gouge. Gouge first from one end of the prism and then from the other; at first you may take off fairly large shavings, but the last stages of the gouging must be done by taking off very small shavings at a time. Finally remove by glass paper any unevenness left after gouging.

Fig. 104.

It is now necessary to chamfer the edges of the base of the inkstand. It will be seen from the side-view (Fig. 102) and from the view of a portion of one of the corners of the base shown in Fig. 105 that the chamfer on the edges of the base does not extend the whole length of the edges, but stops at some distance from the end; hence it is called a "stop chamfer." Mark the position of the chamfer by means of the thumb gauge. Now mark the positions of the ends of the chamfer by marking from each corner points at a distance (*a*) 1" along the edge, and points at a distance (*b*) 1¼" along each of the chamfer boundary lines. Cut the chamfer by means of the chisel (Fig. 106).

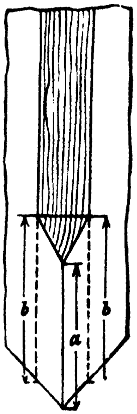


Fig. 105.

Fig. 106.

LESSON 20.

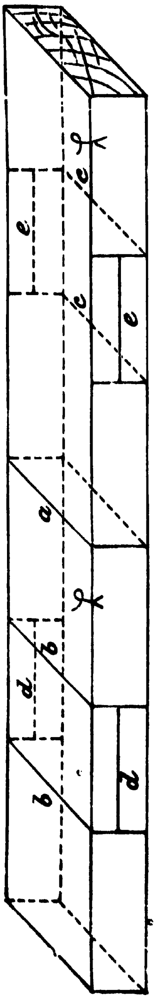


Fig. 108.

Tools used.—Jack Plane, Trying Plane, Tenon Saw, Marking Gauge, Marking Knife, Try-square, Firmer Chisel.

New Tool Manipulation.—*Halving.*

Exercise 17.—*Lapped Halving Joint.*

Make sketches of the class model and then make working drawings (Fig. 107). These drawings should include a section of the joint through the line AB (Fig. 107).

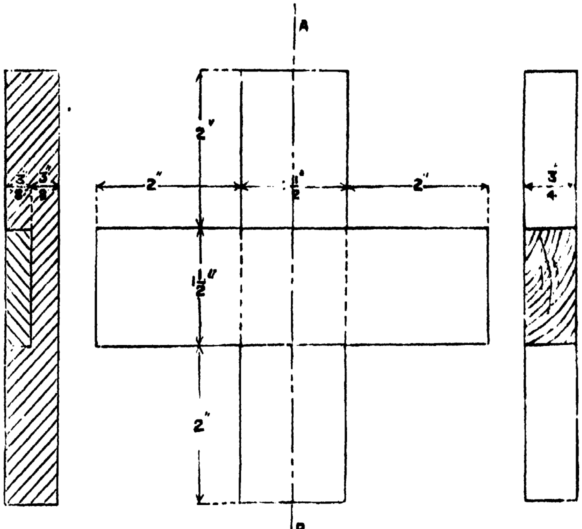
Make a rectangular prism of dimensions 11″ × 1½″ × ¾″. Draw the lines *a*, *b*, *c* (Fig. 108); all these should be drawn with the try-square and marking knife, and afterwards pencilled over.

Gauge on the two sides of the prism the lines *d*, *e*, (Fig. 108).

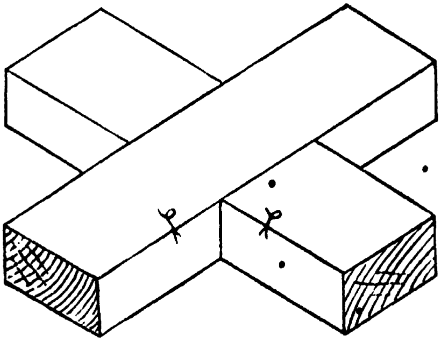
By sawing and horizontal chiselling, as in Exercise 7, cut out grooves by removing wood, (1) between the lines *b* and the gauged lines *d*, and (2) between the lines *c* and the gauged lines *e*.

Saw the wood in halves along the line *a*, and fit the two halves together as shown in the conventional isometric sketch in Fig. 107. The pieces when thus fitted together form what is called a *lapped halving joint.*

In making the grooves you must see that the pieces will fit tightly and yet easily enough to be taken apart. The work is good when the fit is equally exact when one piece is taken out, turned round, and refitted. The grooves are made on opposite sides of the prism so that when the two halves are fitted together their face sides will lie on the *same* side of the joint.



Section on A.B. **Elevation** **Side View**



Conventional Isometric View.

Fig. 107.

LESSON 21.

Tools used.—*Gimlet, Counter Sink Bit,* Jack Plane, Trying Plane, Tenon Saw, Marking Knife, Try-square, Bevel, Screw driver, Compass. Firmer Chisel.

New Tool Manipulations.—*Screwing, boring with gimlet.*

Screws (Fig. 109) are used for holding pieces of wood together. They are more effective for this purpose than nails. They are specially useful for joining pieces which may afterwards have to be taken apart.

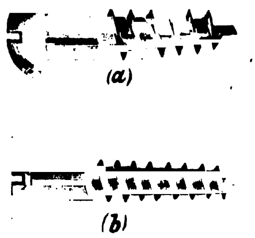


Fig. 109.

Part of the stem of the screw is cut in the form of a spiral; holes bored in the wood for the reception of the screw should be as deep as this spiral portion. Two forms of screws are shown in the figure. From (*a*) has a round head, which remains above the surface of the wood. Form (*b*) has a flat head; the hole into which it is screwed should be widened at the outside end for the reception of the head, so that the top of the latter will be level with the surface.

The Gimlet.—This tool (Fig. 110) is used for boring holes in wood. The point, (*a*), is shaped like a screw and the "shank", (*b*), has cut in it a spiral groove, (*c*), which allows shavings to pass away from the cutting point. Two forms of gimlet are shown in the figure. Form A is the one in ordinary use for boring holes for the reception of screws. From B, called the "auger gimlet," is used for making fairly large holes. It has two small cutters, (*d*), above the screw; these cut the fibres of the wood as the tool is pushed forward.

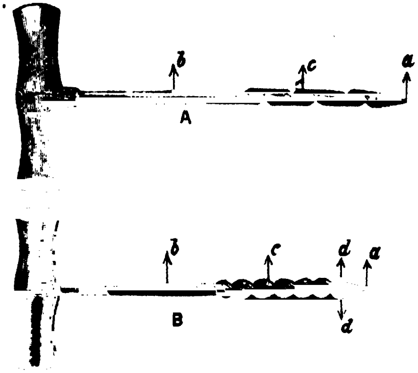


Fig. 110.

The Counter Sink Bit is a useful tool for enlarging the end of a hole made by the gimlet for the reception of a screw, so that the head of the screw may be sunk to such a depth that its top will be on a level with the surface of the wood. The shape of this tool is shown in Fig. 111.

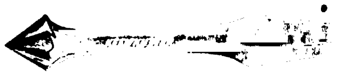


Fig. 111.

Exercise 18.—*Bracket.*

Make sketches of the class model and then make working drawings (Fig. 112).

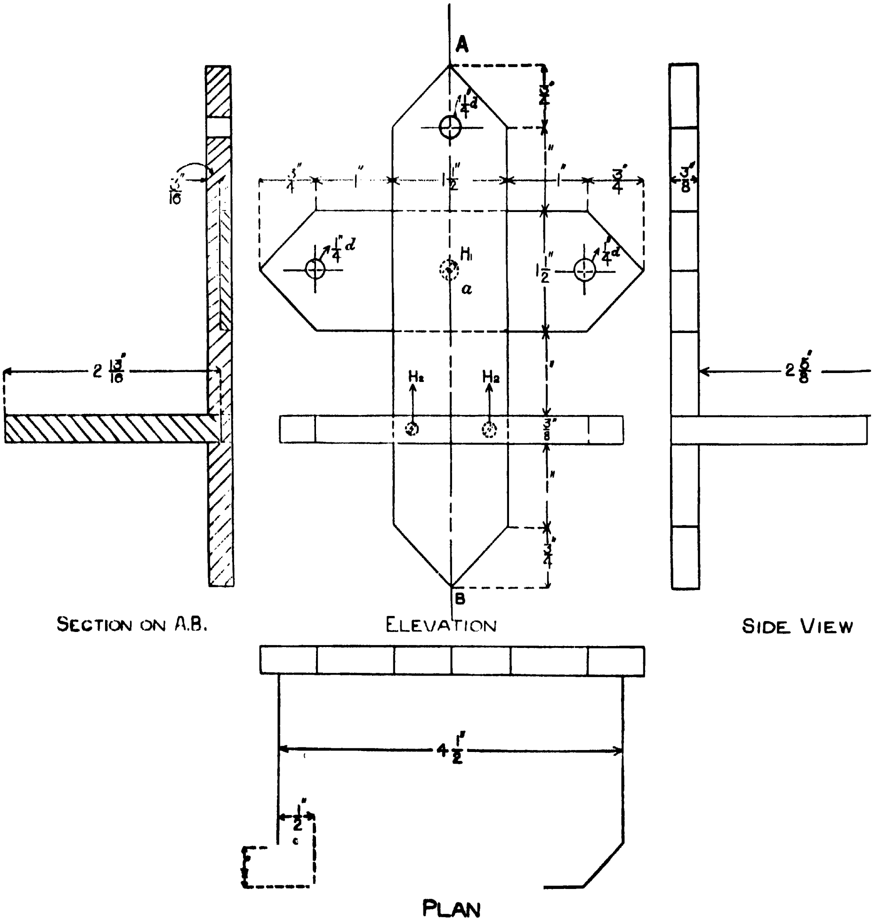


Fig. 112.

These drawings should include a section through the line AB.

Make three rectangular prisms of the following dimensions:—

(*a*) 6⅜″ × 1½″ × ⅜″

(*b*) 5″ × 1½″ × ⅜″

(*c*) 4½″ × 3″ × ⅜″

In (*a*) mark out the lines shown in Fig. 113; these are:—

(1) Lines at 45°, drawn from the centre of each end.

(2) Lines for a groove of ⅜″ width and of depth 3/16″, to be cut on the face side.

(3) Lines for a groove of 1½″ width and of depth 3/16″, to be cut on the opposite side.

(4) A circle of ¼″ diameter; its centre to be at a distance of ¾″ from one end.

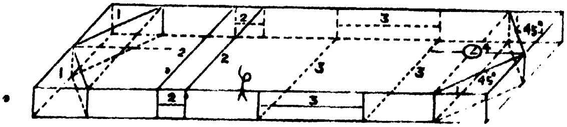


Fig. 113.

In (*b*) mark out the lines shown in Fig. 114; these are:—

(1) Lines at 45°, drawn from the centre of each end.

(2) Lines for a groove of 1½″ width and depth 3/16″.

(3) Two circles of ¼″ diameter; their centres to be each at a distance of ¾″ from the corresponding end.

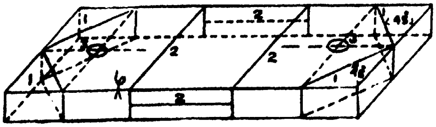


Fig. 114.

In (c) mark out the lines shown in Fig. 115; these are:—

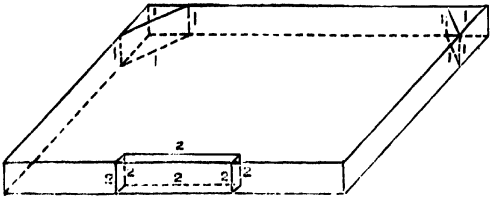


Fig. 115.

(1) Lines for marking where the corners of the platform of the bracket are to be cut off.

(2) Lines for the groove.

Saw off the corners of prism (*a*) along the lines (1). Place the prism horizontally on the bench hook. Bore the holes (4) with the auger gimlet. In doing this be careful to keep the gimlet vertical (Fig. 116).

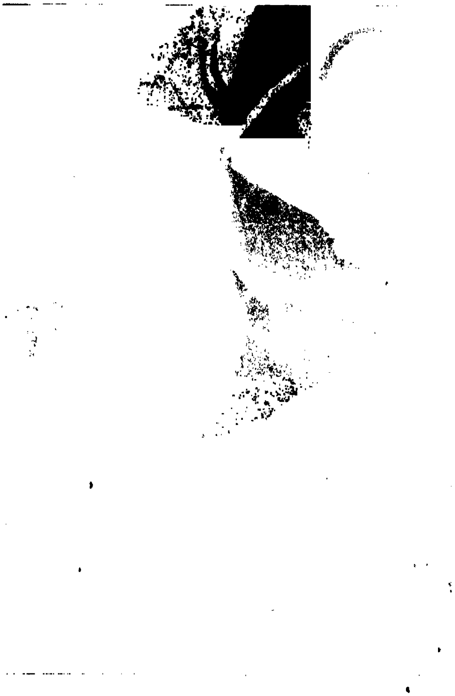


Fig. 116.

Saw and chisel out the grooves (2) and (3). This piece, (*a*), forms the vertical piece of the bracket.

In prism (*b*) bore the holes (3) with the auger gimlet, saw off the corners along the lines (1), and saw and chisel out the groove (2). This piece, (*b*), forms the cross piece of the bracket.

In prism (c) cut the groove (2) by sawing through the edge to a depth of $\frac{3}{16}''$, and by vertical chiselling. Saw off the corners along the lines (1).

This piece forms the platform of the bracket.

Now fit the pieces (*a*) and (*b*) together, as shown in the elevation drawing (Fig. 112). From the back of the cross piece bore with the bradawl a hole at H_1 for a screw. Widen the mouth of this hole slightly with the counter sink bit (Fig. 117) to receive the head of the screw, and screw the two pieces together.

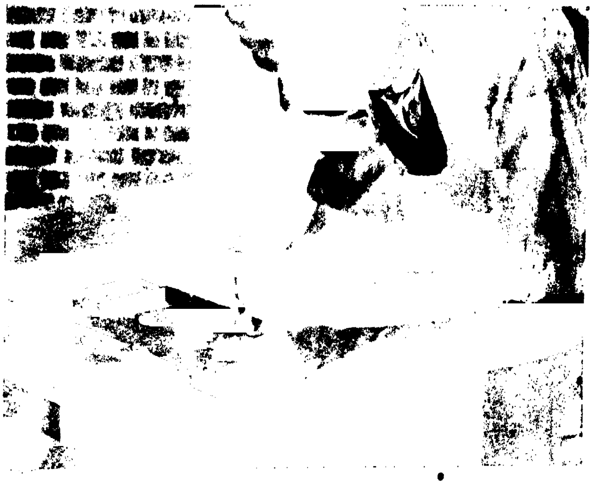


Fig. 117.

Fit the platform (*c*) to the vertical piece (*a*), and screw it in by two screws (H_2, Fig. 112), inserted from the back of piece (*a*).

LESSON 22.

Tools used.—Jack Plane, Trying Plane, Marking Knife, Try-square, Tenon Saw, Marking Gauge, Smoothing Plane, Firmer Chisel.

Exercise 19.—*Housing Joint.*

Make sketches of the class model and then make working drawings (Fig. 118).

Make a rectangular prism $8\frac{1}{8}'' \times 2'' \times \frac{3}{4}''$. Cut from it two prisms :—

(*a*) $4\frac{3}{4}'' \times 2'' \times \frac{3}{4}''$, and

(*b*) $3\frac{3}{8}'' \times 2'' \times \frac{3}{4}''$.

In (*a*) cut a groove $\frac{3}{4}'' \times 2'' \times \frac{3}{8}''$, at a distance of 1″ from one end. Fix the piece (*b*) into the groove, as shown in the elevation of the drawing. This joint is called a *housing joint.*

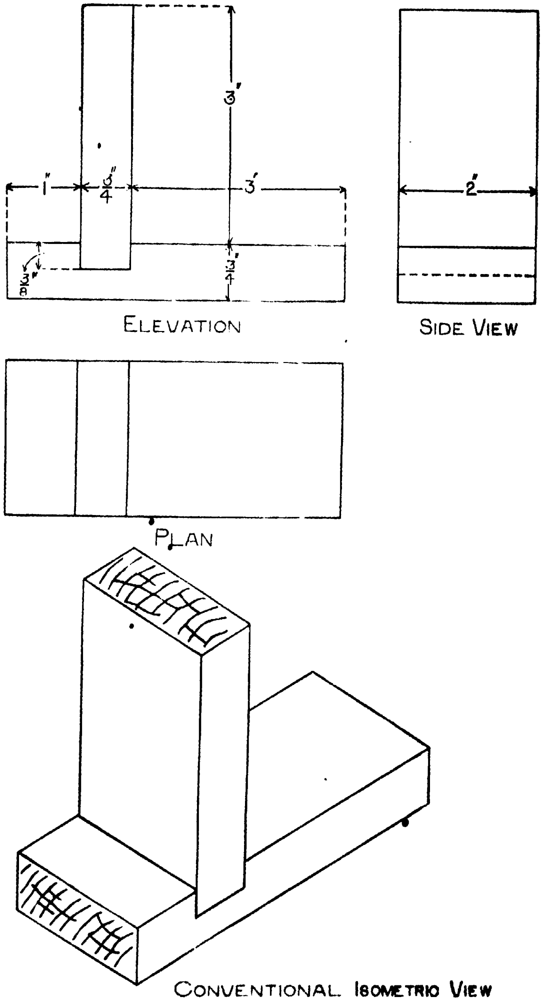

3"
1"
3/4"
3"
3/4"
3/8"
2"
ELEVATION
SIDE VIEW
PLAN
CONVENTIONAL ISOMETRIC VIEW

Fig. 118.

LESSON 23.

Tools used.—Jack Plane, Try Plane, Try-square, Marking Knife, Marking Gauge, Tenon Saw, Smoothing Plane, Firmer Chisel, Bradawl, Gimlet, Nail Punch, Hammer.

Exercise 20.— *Letter Rack.*

Make sketches of the class model and then make working drawings (Fig. 119).

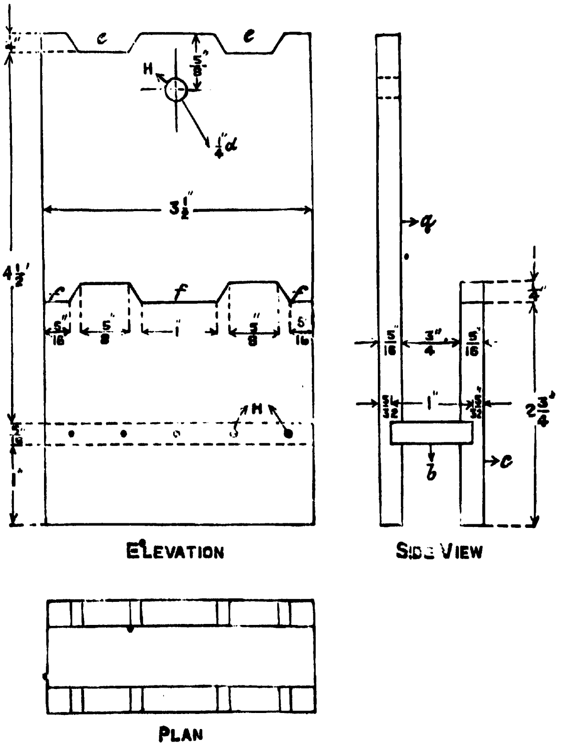


Fig. 119.

Make three prisms:—

(*a*) $6\frac{1}{16}'' \times 3\frac{1}{2}'' \times \frac{5}{16}''$.

(*b*) $3'' \times 3\frac{1}{2}'' \times \frac{5}{16}''$.

(*c*) $1'' \times 3\frac{1}{2}'' \times \frac{5}{16}''$.

On the piece (*a*) draw construction lines for the end grooves (*e*) (Fig. 119), and for the groove for the housing joint with (*b*). Mark the position of the centre of the small hole (*d*), which is made near the top of the piece; this hole is for suspending the letter rack from a nail.

Cut out the end grooves (*e*) by making oblique cuts with the tenon saw through the edge, and chiselling out the wood between them. Bore the hole (*d*) with the auger gimlet, and make the groove for the housing joint.

On the piece (*c*) draw construction lines for the end grooves (*f*), and for the groove for the housing joint with (*b*). Saw and chisel out the end grooves (*f*), and make the groove for the housing joint.

Fit the pieces (*a*), (*b*), and (*c*) together and nail (*a*) and (*c*) to (*b*); the positions for the nails H are shown in Fig. 119.

APPENDIX

CARE OF TOOLS.

Rust.—A tool soon becomes destroyed if rust is allowed to form on it With proper care rust will not form on tools, but, if through want of attention, rust has formed, it should be removed by oil and emery paper as soon as detected. In order to prevent tools rusting, all iron parts should be smeared with vaseline when the tool is not in use. This should invariably be done before the school closes for a vacation; special vigilance will be needed in the Rains.

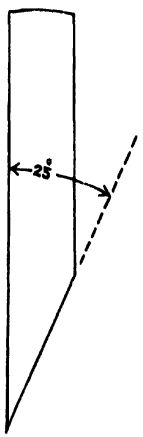


Fig. 120.

Sharpening.—A blunt tool wastes time and labour, and makes it impossible to do accurate work. The following rules are sufficient for guidance in sharpening all tools in common use:—

(*a*) **Chisels**.—When a chisel is received from the maker, the shape of the blade is as shown in Fig. 120.

Sometimes the tool is found to be sharp enough to do good work at once, but as a rule it has to be sharpened on the oil-stone. The *oil-stone* (Fig. 121) is a rectangular slab of very fine sandstone.

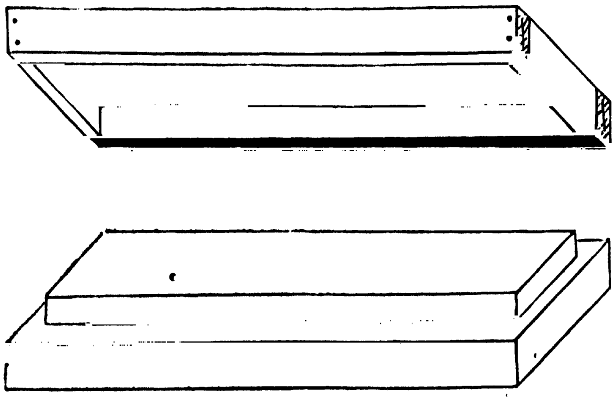


Fig. 121.

It is encased in a wooden box which keeps it clean and prevents breakage. The best form of oil-stone is the *Washita.*

To sharpen the chisel on the oil-stone proceed as follows :—Pour some linseed oil on the surface of the stone ; this will prevent grit gathering in the pores of the stone. To sharpen the tool you have to remove a small portion of the edge and so form a new face, called the "sharpening face," at an angle of about 35° to the straight face. (Fig. 122.)

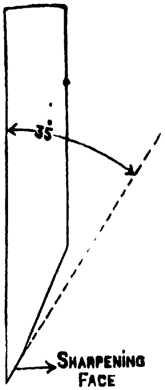


Fig. 122.

In order to do this hold the tool as shown in Fig. 123 and move it steadily backwards and forwards, using the whole surface of the stone, and taking care that the edge of the tool does not dig into the stone.

In order to get a sharp edge it is important to keep the tool at the

Fig. 123.

same angle and have the whole of the new face in complete contact with the stone. In this process a portion of the edge will probably become turned up, forming what is called a "wire edge." To remove this the tool should be turned round, placed flat on the stone, and. rubbed backwards and forwards two or three times (Fig. 124.)

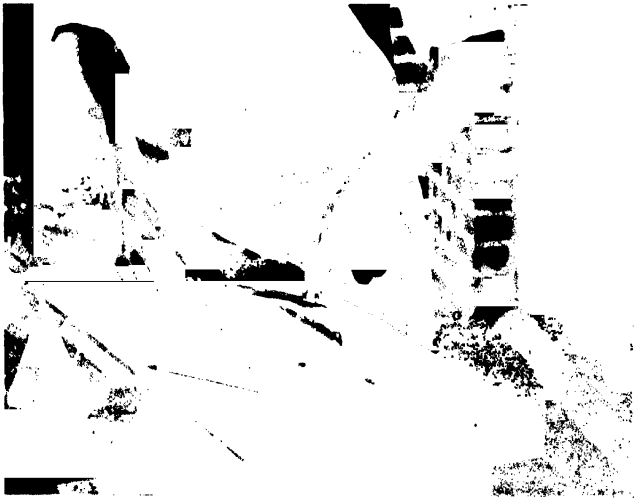


Fig. 124.

The tool is sharp when the edge cannot be seen when held up to the light. The stone should be cleaned with a rag before being put away. If, owing to use, its surface becomes uneven it should be rubbed with No. 3 emery paper.

By repeated sharpening the "sharpening face" becomes large, and so it becomes difficult to sharpen it uniformly. The tool must then be ground on the grindstone until it is again of the shape shown in Fig.

120, after which a new small sharpening face may be formed on the oil-stone. The grindstone consists of a circular slab of sand-stone which rotates on an axle. Fig. 125 shows a grindstone encased in a frame, which prevents the water which is poured on the stone from splashing.

Fig. 125.

In the form of stone shown in the figure the water is run on to the stone from a small can. The object of the water is to keep the tool cool and to wash away any grit during the process of grinding.

To grind the tool to the required angle it should be placed on the stone as shown in Fig. 126.

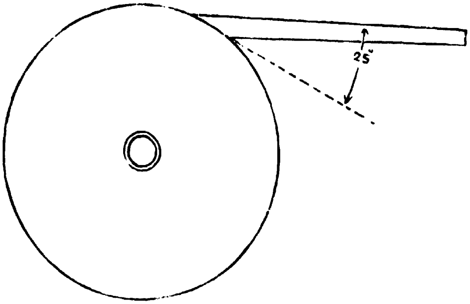


Fig. 126.

It may be held in the right hand and pressed on the stone with the left hand as the stone rotates. (If there is not a treadle on the stone a companion should assist by turning the handle.) In order that the stone may be worn away uniformly the tool should be moved from side ,to side during the process of grinding. Without some mechanical contrivance it is difficult to keep the tool on the stone at the right angle. Fig. 125 shows one useful form of grinding support. By adjusting the frame in which the tool is fastened nearer or further away from the stone, the edge of the tool may be placed on the stone at the correct angle.

After grinding, care should be taken to run the water off from the trough, as otherwise it will soften the stone. It is important to remember also that a stone should not be left in the sun, which makes it hard.

(*b*) **Plane Irons.**—Following the directions given in Lesson IV take out the irons. Place them flat on the bench and loosen the screw with the screw-driver (Fig. 127). Take out the cutting iron.

Fig. 127.

The cutting irons of the trying and smoothing planes are sharpened like the chisel. Fig. 128 shows how the iron is held when moved on the oilstone.

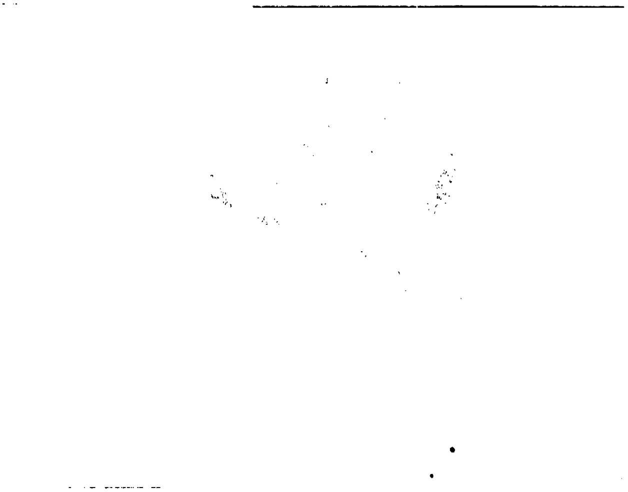


Fig. 128.

In the case of the cutting iron of the Jack Plané (see Fig. 68) a little more must be taken off the corners than off the centre of the edge. This is done by moving the iron backwards and forwards on the oilstone, the direction of the stroke being as shown in Fig. 129.

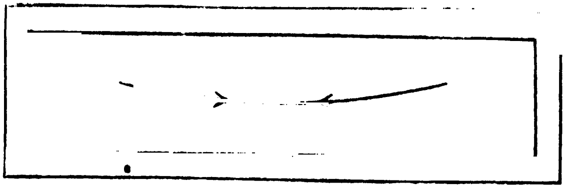


Fig. 129.

In the case of all three irons the "wire edge" is removed and the irons are ground on the grindstone in the same manner as in the case of the chisel.

(c) **Bradawl.**—The two bevelled faces of this tool should be sharpened on the oilstone at the original angle.

(d) **Screw-driver.**—The two bevelled faces of this tool should be sharpened on the grindstone at the original angle. Unlike the bradawl the screw-driver is not ground to a sharp edge; the width of the edge should be a little less than that of the groove of the screws for which the screw-driver is intended.

(e) **Gouge.**—The gouges which you use have the bevelled edge on the inside. It is not possible therefore to sharpen them on the flat oilstone. A special oilstone called a *slip* is used; the slip is an oilstone rounded to the shape of the tool. The tool is held stationary as shown in Fig. 130, and the slip rubbed along it until a fine edge is formed. The slip should, like the flat oilstone, be oiled before being used.

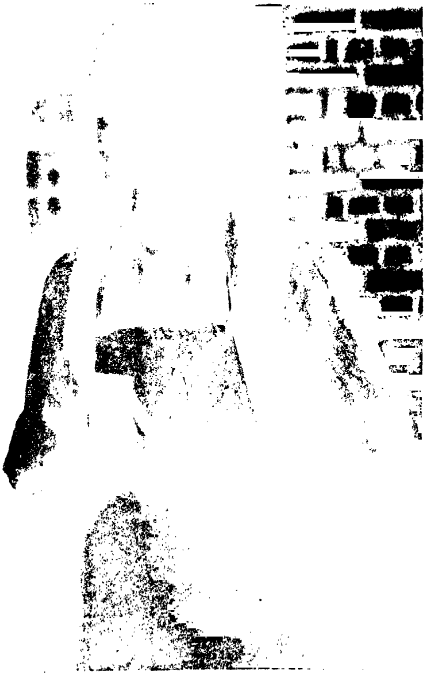


Fig. 130.

The *wire edge* is removed by rubbing the tool from side to side on the oilstone.

FURNISHING AND EQUIPPING A MANUAL TRAINING WORKSHOP.

PLAN OF MANUAL TRAINING WORKSHOP.

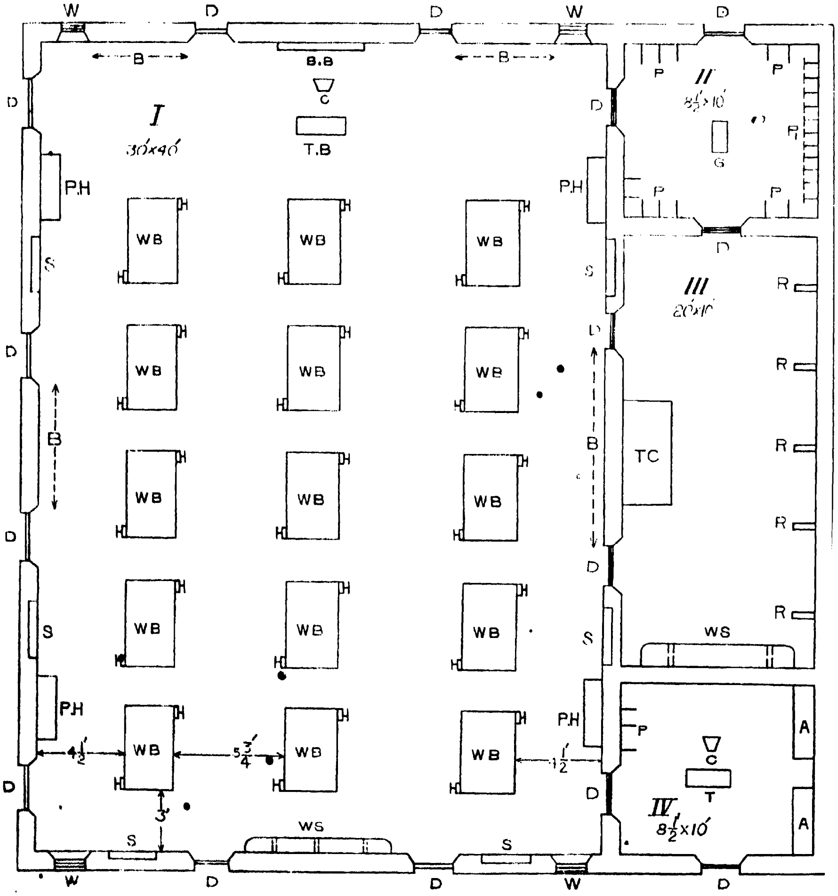


Fig. 181.

Furniture.

(a) Work Bench:

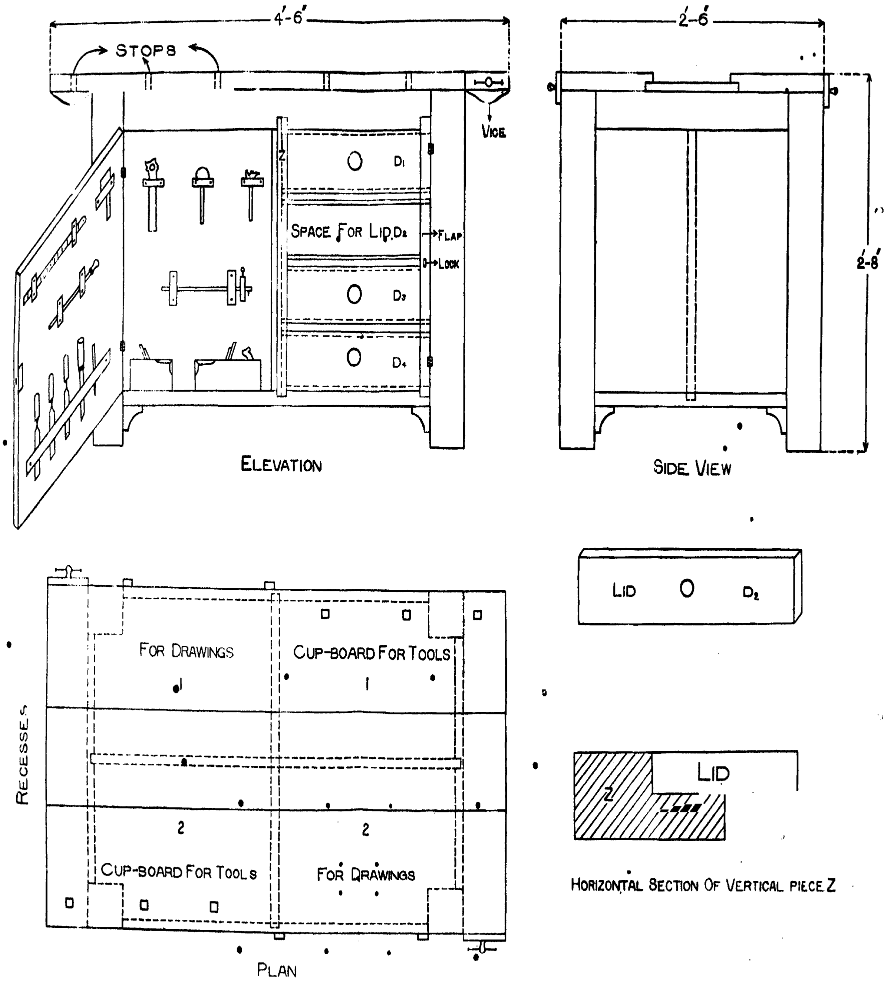


Fig. 132.

REFERENCES TO PLAN OF WORKSHOP.

ROOMS—	
I ...	Workshop.
II ...	Lavatory.
III ...	Store Room.
IV ...	Teacher's Room.
FURNITURE—	
W. B. ...	Workshop Bench (see Fig. 132.)
P. H. ...	Pigeon-hole cupboard, for finished exercises and drawings (see Fig. 133).
C. ...	Chair.
T. B. ...	Teacher's Work Bench.
T. C. ...	Tool Cupboard (see Fig. 134).
T. ...	Teacher's Desk.
A. ...	Almirahs.
FITTINGS—	
W. ...	Windows.
D. ...	Doors.
B. B. ...	Black Board.
B. ...	Two parallel rows of 4" wooden beading, to run along the walls; one at a height of 4', and the other at a height of 7'. These are useful for nailing to the wall models, pictures, drawings, etc.
S. ...	Stone shelves with glass doors.
W. S. ...	Wooden shelves.
P. ...	Wooden pegs for coats.
P_1. ...	Water pipes for washing.
G. ...	Position of grindstone.
R. ...	Five rows of iron brackets for storing wood horizontally.

The bench shown in the figure has been designed for two boys working at the same time and for four classes working at different times. D_1, D_2, D_3, D_4 are four recesses in front of which are lids, which may be taken off on opening the flap. By means of the flap it will be possible to have one recess open and the others closed simultaneously. Thus boys in Class I use recesses D_1 (one on each side of the bench); boys in Class II use D_2, and so on.

The special advantage of this recess arrangement is that the boys in a particular class, while having access to their own drawings and models, are unable to interfere with those of boys of other classes.

The cupboards for tools are to be fitted to take the tools shown, but the tools are otherwise provided for.

(*b*) **Pigeon-hole cupboard** :

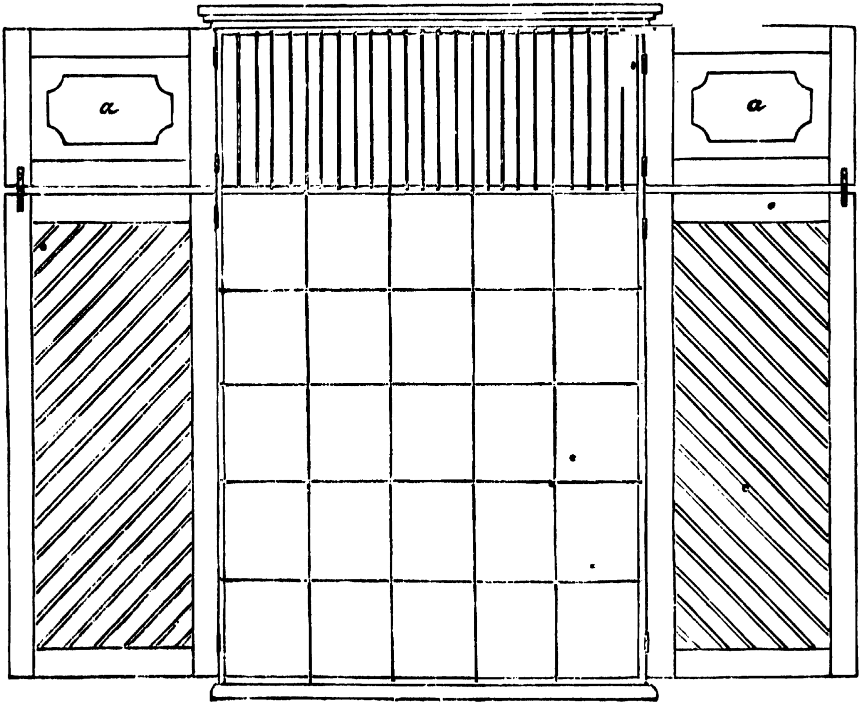


Fig. 133.

This cupboard is used for storing the drawing boards and the finished work of the different classes. Its size is 8′×5′6″×1′6″.

The part in which the drawing boards are stored should have doors (*a*, *a*) opening independently of the part in which completed work is stored. The sketch shows the general arrangement of pigeon holes for drawing boards and completed work respectively.

(c) Tool cupboard:

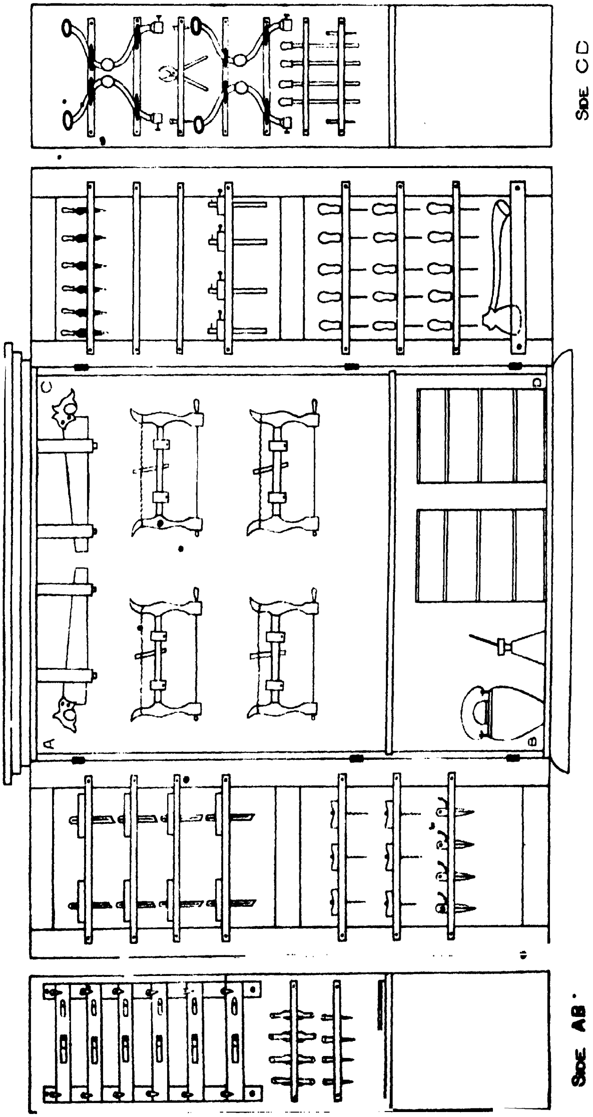


Fig. 134.

Size : 7′ × 5′ × 2′6″, with one shelf 2 feet from floor.

The doors, sides, and back of this cupboard should be fitted to take the tools which are common to the class. The space under the shelf may be used for storing glue-pot, boxes of nails, etc. The figure shows the sides, doors, and back fitted with tools. Fig. 135 is a photograph of this cupboard fitted with more tools than are shown in Fig. 134.

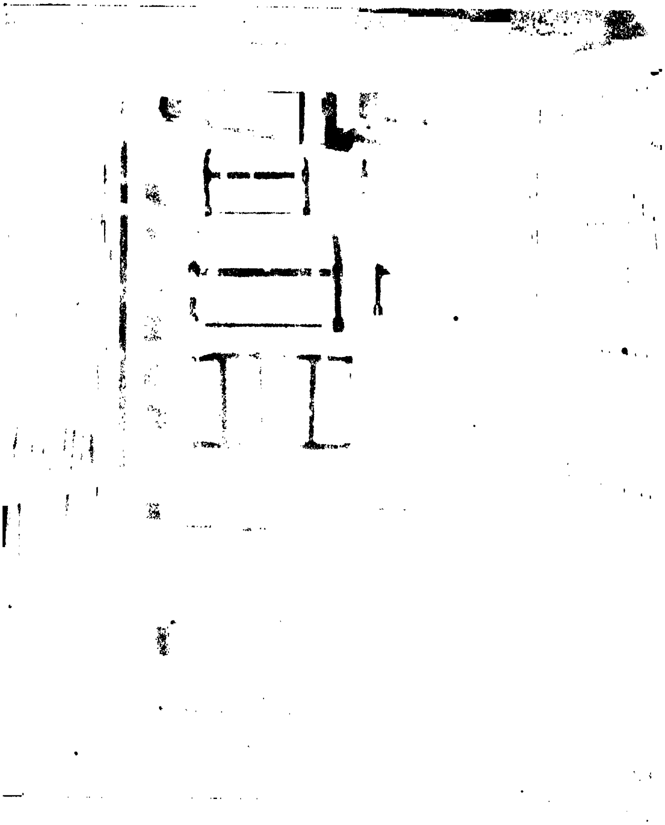


Fig. 135.

EQUIPMENT REQUIRED FOR A CLASS OF 30 PUPILS.

(*a*)—NON-CONSUMABLE.

(1)—One Item per pupil. To be stored in the Work Benches.

Serial No.	Description.	Particulars.	Number required.	Rate.	Remarks.
				Rs. a. p.	
1	Jack Plane ...	16 × 2¾″ ; 2⅛″ iron	30 ...	2 4 0 each.	
2	Smoothing Plane ...	8″ ; 2⅛″ iron	30 ...	1 14 0 „	
3	Try-square (wooden stock)	7½″ ...	30 ...	1 0 0 „	
4	Marking knife (handled)	6″ ...	30 ...	0 7 0 „	
5	Foot rule (steel) ...	12″ ...	30 ...	1 10 0 „	
6	Marking gauge ...	...	30 ...	0 6 0 „	
7	Tenon-saw ...	Blued back 10′	30 ...	1 12 0 „	
8	Hammer	No. 2 ...	30 ...	0 10 0 „	
9	Mallet	...	30 ...	0 8 0 „	
10	Screw-driver ...	6″ ...	30 ...	0 8 0 „	
11	Firmer chisel ...	⅜″ ...	30 ...	2 4 0 dozen.	
12	„ „ ...	⅝″ ...	30 ..	3 0 0 „	
13	„ „ ...	1″ ...	30 ...	4 8 0 „	
14	Bench hook ...	...	30 ...	...	From Bazaar.
15	Nail Punch ...	3/32″ ...	30 ...	0 4 0 each.	

NON-CONSUMABLE—(*continued*).

(2)—Common to the class. Tools to be stored in the Tool Cupboard.

Serial No.	Description.	Particulars.	Number required.	Rate.				Remarks.
				Rs.	a.	p.		
16	Grindstone	16″×3″	1	3	12	0	each.	
	(or in trough)	...		18	14	0	„	
17	Trying plane	20″×3″×3¼″ deep, and 2¼″ iron.	6	4	4	0	„	
18	Rip saw	28″	1	2	8	0	„	For Teacher.
19	Cross-cut saw	22″	1	2	6	0	„	„ „
20	Panel saw	18″	2	1	12	0	„	„ „
21	Try-square (wooden stock)	12″	2	1	4	0	„	„ „
22	Cutting gauge	...	1	0	9	0	„	„ „
23	Axe	3¼″	1	2	0	0	„	„ „
24	Holdfast (G. Cramp)	6″	8 pairs	1	12	0	pair.	
25	Saw file (triangular)	5″	6	1	10	0	dozen.	For Teacher.
26	Bevel square	9″	10	1	8	0	each.	
27	Compasses (wing)	6″	5	1	4	0	„	
28	Pairs of pliers (flat nose)	5″	2	0	14	0	„	
29	Auger gimlet	¼″	12	3	0	0	dozen.	
30	Starrett's nail sets	No. 5	2	0	7	0	each.	
31	Straight edge (steel)	24″×1½″	1	3	0	0	„	For Teacher.
32	Scrapers	2″	2	1	12	0	„	„ „
33	File cleaner	No. 1	2	0	10	0	„	
34	Stock books	...	2		...			From Daftari.
35	Counter sink bit	...	5	0	9	0	each.	
36	Bradawls	Various	18	1	2	0	dozen.	
37	Spare blades for bradawls	Various	18	0	7	0	„	
38	Oilstone in case	7″×1¾″	8	1	12	0	each.	
39	Oilstone slip	...	8	0	14	0	„	

(*b*)—CONSUMABLE.

(To be renewed each year.)

1—*General*.

Serial No.	Description.	Particulars.	Number required.	Rate.				Remarks.
				Rs.	a.	p.		
1	French wire nails ...	½'' ...	4 lbs. ...	0	6	0	per lb.	
2	" " " ...	¾'' ...	2 lbs. ...	0	5	0	per lb.	
3	Glass paper ...	No. 1 ...	3 qrs. ...	0	9	0	per qr.	
4	Emery cloth ...	No. 1 ...	5 qrs. ...	1	2	0	per qr.	
5	Labels for affixing to Models	2½''×1''...	1000 ...	...				From Bazaar.
6	Dusters		3 doz. ...					" "
7	Linseed oil (boiled) ...		4 pints.					" "
8	Vaseline		2 lbs. ...					" "
9	Towels		6 ..	...				" "
10	Soap		4 lbs. ...	...				" "
11	Paste (for pasting paper)		2 bottles					" "
12	Attendance Register...		1					From Daftari.
13	Diary		1					" "
14	Mark Register ...		1					" "

CONSUMABLE—(*continued*).

(To be renewed each year.)

2—*Wood.*

Serial No.	Description.	Particulars.	Quantity required.	Remarks.
1	Nim Chambeli or Bakain ...	In planks, 1″ thick ...	12 cu. ft. ...	From Bazaar.
2	Tun	½″ „ ...	1 „ ...	„ „
3	Mango	1″ „ ...	1 „ ...	„ „
4	Shisham	1″ „ ...	1 „ ...	„ „
5	„	2″ „ ...	1 „ ...	„ „
6	Haldu	1″ „ ...	2 „ ...	„ „
7	Teak	1″ „ ...	1 „ ...	„ „

NOTE.—The tools mentioned in the above lists may be procured from Messrs. T. E Thomson & Co., 9, Esplanade East, Calcutta.

CHART OF THE GRADED EXERCISES IN THE COURSE.

This table shows the tool manipulations involved in making the exercises of the course.

* Indicates a new tool manipulation.

† Indicates revision of a tool manipulation previously learnt.

Serial number of tool manipulation.	Name of tool manipulation.	Serial No. and name of exercise.																				Number of times each tool manipulation occurs in the course.
		1 Preliminary (Planing).	2 Preliminary (gauging).	3 Rectangular Prism.	4 Square Prism.	5 Prism with longitudinal cuts.	6 Prism with oblique cuts.	7 Wooden Pattern (a).	8 " " (b).	9 " " (c).	10 Rhombus with chamfered edges.	11 Prism with inlaid pieces.	12 Match Box Holder.	13 Name Board.	14 Stool.	15 Round Ruler.	16 Inkstand.	17 Lapped Halving joint.	18 Simple Bracket.	19 Housing joint.	20 Letter Rack.	
1	Face planing ...	*		†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	19
2	Edge planing	*		†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	19
3	Gauging		*	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	19
4	Marking with knife ...			*	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	18
5	Sawing with tenon saw at right angles to the grain.			*	†	†	†	†	†	†		†	†	†	†	†	†	†	†	†	†	17
6	End planing			*	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	18
7	Sawing with tenon saw with the grain.					*																1
8	Use of Bevel ...						*		†	†	†	†		†	†			†	†			9
9	Use of Screw-driver ...						*		†	†	†	†		†	†			†	†			9
10	Sawing through a face obliquely to the grain.						*		†		†	†		†					†			6
11	Horizontal chiselling across the grain.							*		†		†						†	†	†	†	7
12	Horizontal chiselling obliquely to the grain.								*			†										2
13	Sawing through an edge obliquely to the grain.									*					†			†				3
14	Vertical chiselling obliquely to the grain.									*			†	†			†					4
15	Chamfering with plane with the grain.										*		†				†					3
16	Chamfering with chisel across the grain.										*		†				†					3
17	Vertical chiselling obliquely to the grain.											*		†							†	3
18	Inlaying											*		†								2
19	Vertical chiselling at right angles to the grain.												*	†	†		†	†	†	†	†	8
20	Horizontal chiselling with the grain.												*	†	†		†					4
21	Boring with Bradawl ...														*				†		†	3
22	Nailing														*						†	2
23	Use of compass ...															*	†					2
24	Modelling with jack plane.															*						1
25	Filing															*						1
26	Gouging																*					1
27	Stop chamfering ...																*					1
28	Halving																	*	†			2
29	Screwing																		*			1
30	Boring with Gimlet ...																		*		†	2
31	Housing																			*	†	2
	No. of tool manipulations in each exercise ...	2	1	6	6	7	9	7	10	11	10	13	11	14	13	9	14	12	15	9	13	